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Purposeful scientific research is a basic pillar for the advancement of Iraq

Radiative properties of Microstrip Patch antenna at dual band and dual feed

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ABSTRACT

A new design model is proposed for microstrip patch antenna which works with dual band and dual feed technology, the antenna patch is designed with copper material in rectangular shape. The proposed antenna operates on two frequencies, the first 2.4GHz and the second 5GHz, which is suitable for WLAN applications. This antenna was designed by a 3D simulation program CST Microwave Studio 2019 and from the simulation results we obtained, the VSWR quantity at the first frequency was 1.108281 and at the second frequency its value was 1.199105, and the return loss at the first frequency was -25.8787 dB and at the second frequency -20.863 decibels. As for the directivity, the value at the first frequency was 3.497 decibels, and at the second frequency was 3.315 decibels. These are excellent results and are consistent with the required experimental results.

Keywords: directivity, WLAN, CST, dual-band,Microstrip.

Introduction

The recent period of the past decades has witnessed a great and tremendous development in wireless communication technology, which has replaced an ideal alternative to wired communications and its manifold wires. Electromagnetic waves range from waves propagating through wires to waves propagating in a vacuum. The Microstrip Patch antenna, which was first proposed in 1953 by the scientist Deschamps, is one of the best and most modern types of antennas that are used in a wide range of electromagnetic applications. It is used in the range of wireless communications on a wide range because of its many properties and advantages, most notably its small size, light weight and low cost, as well as It supports two types of polarization, linear and circular, and with all these advantages, it has some disadvantages, most notably low gain, narrow bandwidth, and not high radiation efficiency. **[1]**

These advantages have greatly helped the use of this type of antenna in particular in many applications, including military applications, such as aircraft, missiles, spacecraft, personal communications (GSM), direct broadcasting via satellite (DBC), wireless local area network (WLAN) and wireless local area networks (WLAN) systems. highways, smart cars and global applications such as GPS systems These antennas are used in applications operating in the 100MHz to 50GHz range **[2]**

The Microstrip Patch antenna It contains of three layers or levels. The first level is made of a conductive material and is called the ground level. A dielectric substrate with an insulating constant is installed directly above it, suitable for the application used, and with the same dimensions as the ground level. As for the third level, it is called the radioactive patch and it is made of conductive material as well. Such as copper or gold, and its dimensions can be calculated using mathematical equations, which we will address in the next paragraphs of this research. The patch takes different shapes, and the radiating patch and the feed line are usually printed on the insulating substrate on one side of the insulating substrate and the ground plane on the other side. As shown in the figure **1** below **[3].**

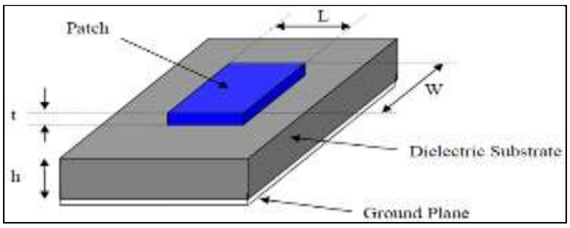

Fig. 1: Installation of the Microstrip Patch antenna

The radioactive patch is manufactured in different shapes and sizes, and in most practical applications it takes the shape of the patch, either rectangular, square or circular, but the most commonly used patch is either rectangular or square because it is easy in terms of installation and manufacture **[4]**

Through the frequencies used in the proposed model, we will work on WLAN applications It is a wireless local area network, very similar to a wired LAN, but it provides communication by radio waves instead of traditional communication through physical connectors as in LAN. One of the advantages of a WLAN network is that the subscriber has the freedom to move within a limited range without interruption in the connection, and then this network combines data transfer services when moving.

A WLAN network is made up of a central link unit called the Access Point, which is similar to the hub or switch that is used in the LAN, so the access point transfers data between different devices such as computers, mobile devices or any other devices that contain a wireless communication card. Within a WLAN, it often provides communication between LANs and WLANs, so a high-efficiency access point (AP) is able to manage a large group of users when it is within the network workspace **[5].**

antenna design : Designed this antenna by CST Microwave Studio 2019 software, this antenna is designed with dual feed plus dual band technology that work for WLAN applications. The FR-4 insulating substrate was designed with a dielectric constant of 4.3, while the radioactive patch material and the ground level were used for designing copper and as in the dimensions shown in the table below, where the model was designed first with one feed and then we added another feed and we cut a square piece from the center of the patch Let's see improvements in design results.

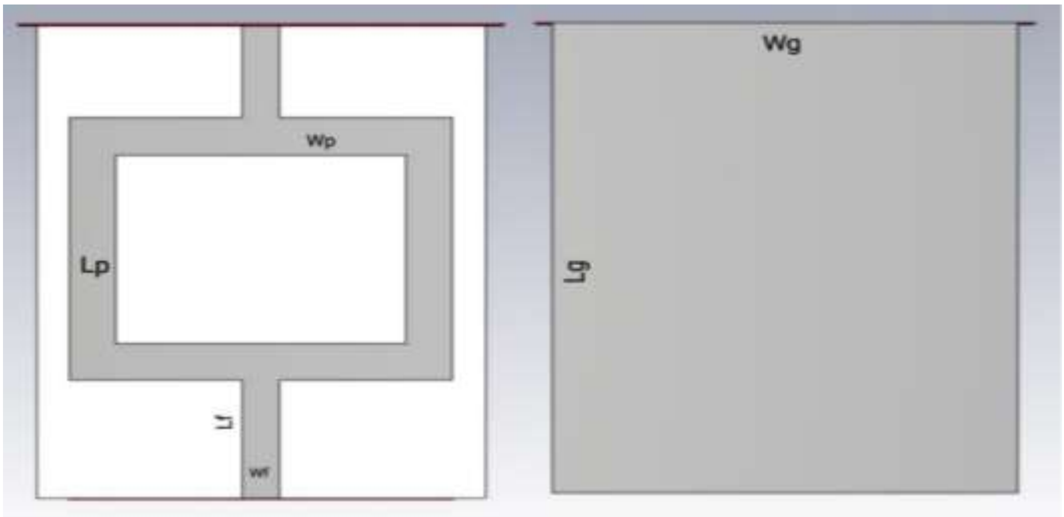

Fig. 2: Suggested antenna design

The dimensions of the proposed antenna are shown in the table below

Dimensions	Ws	Ls	Wg	Lg	Wp	Lp	Wf	Lf	t	H
Values (mm)	27	36	27	36	23	20	2.3	9	0.06	1.6

Dimensions calculation

patch width(wp): The width of the proposed antenna patch was calculated using the following mathematical equation**[6].**

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \text{ ……….. } \mathbf{1}$$

W: patch width

f_r: Antenna working frequency

ε_r: dielectric constant

patch length(lp): The patch was calculated using the following mathematical equation **[7].**

$$L = L_{eff} - 2\Delta L \text{ …….} \mathbf{2}$$

L_{eff} : effective length

C: light's speed

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}} \text{ ….} \mathbf{3}$$

h: pedestal height

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-\frac{1}{2}} \text{ …..} \mathbf{4}$$

ε_{reff}: Effective dielectric constant

Results and Discussion

return loss: It is one of the most important properties of the antenna and represents a measure of the effectiveness of the power delivery through the transmission line towards the antenna, and through it we can express the compatibility between the two input impedances and the transmission line. **[8]**

Through the simulation results that appeared, it was found that the return loss at the first frequency, 2.4GHz, was -25.787dB. The second frequency was 5 GHz -20.863dB, we find here that the results are excellent at both frequencies and correspond to the required experimental results as shown in the figure **3** below.

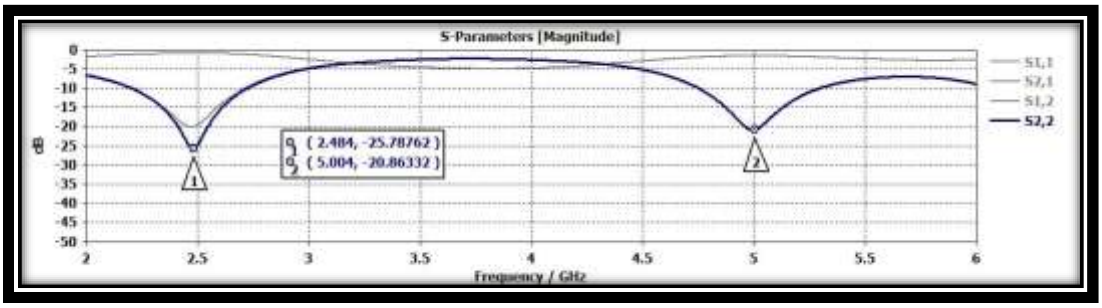

Fig. 3: showing the return loss of the designed antenna

Voltage Standing wave (VSWR) : One of the important properties of the antenna is the ratio between the maximum value of the amplitude of the voltage to the minimum value of the amplitude of the voltage, and its value must be between one and two in order for the antenna to work well. It also depends on the compatibility of the impedances, where when the impedances do not match, standing waves will arise that hinder the transmission of energy **[9].**

Through the simulation results that we obtained, we found that the value of the voltage of the wave standing at the first frequency is equal 1.108dB, but at the second frequency its value is equal to 1.199dB. These are good results that are consistent with the experimental results, as its value must be greater than one and less than two in order for the antenna to work well. As shown in the figure **4** below.

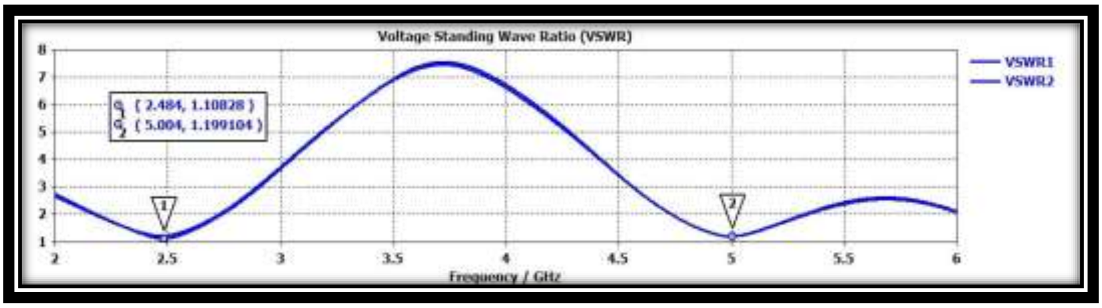

Fig. 4: showing the VSWR of the designed antenna

Directivity: It represents a measure of the quality of the antenna radiation in a particular direction and represents the product of gain divided by efficiency **[10]**

Through the results of the designed antenna simulation, we found that the directivity value at 2.4GHz is 3.249dB and its value at 5 GHz is 3.315dB. As we know that the directivity is the result of dividing the antenna efficiency by the antenna gain. Through the results we obtained from the simulation, we find that its value is good at the two frequencies and is compatible with the required experimental results as shown in the figure **5** below.

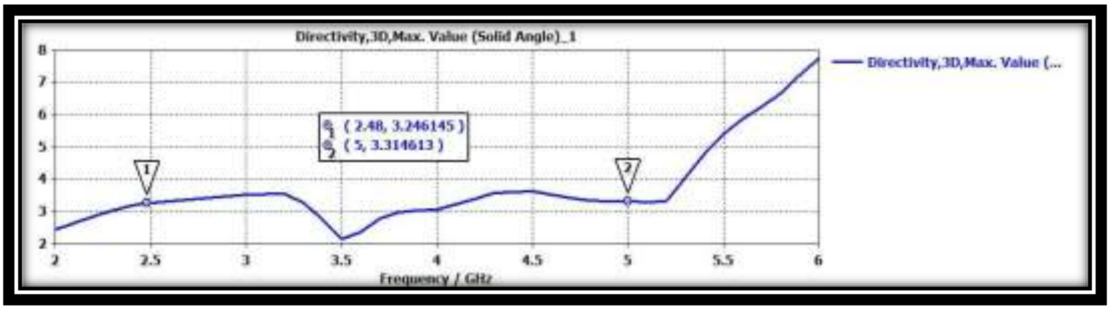

Fig. 5: showing the directivity values of the designed antenna

Smith chart: It is a graphical aid for engineers to solve matching problems incircuits and transmission lines. Smith's chart can be used to simultaneously show several parameters: reflection coefficients, impedances, acceptance, S parameters, and mechanical vibration analysis.

From the simulation results, we found that at the first frequency, the real part of the input resistance is equal 49.004 ohm, the value of the imaginary part of the input resistance 4.987ohm, at the second frequency it was found that the value of the real part of the input resistance is equal59.658 ohm, and the imaginary part of the input resistance is equal 2.149 ohm. The resistance of the real part of the input resistance should be close to 50 ohm, while the resistance of the imaginary part must be close to zero. So these results are excellent and are consistent with the required experimental results. And as shown below.

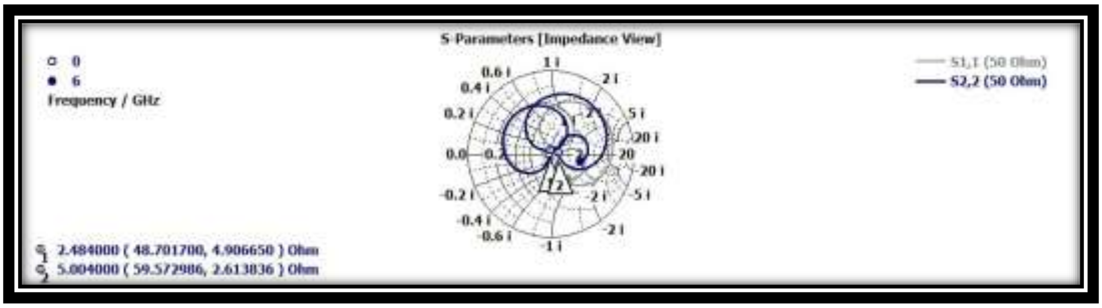

Fig. 6: Smith Chart for the proposed model

Conclusion

In this paper, we take four properties of the designed antenna and study their properties. In the first case, the antenna was designed with a single feed and without cropping part of the radiated patch, then the return loss was -3.0711dB for the first frequency and -4.5407dB for the second frequency, and thus the results did not meet the requirements of the desired results

To improve the performance of the antenna and get good results, we cut a square piece in the middle of the radiant patch with dimensions of 16 x 16 mm and a second feed was added. The results after this modification were excellent, as we obtained a return loss of -25.7876dB at the first frequency and -20.8633dB at the second frequency and with an improvement return loss the input impedance, both real and imaginary, improved, as well as the results of the standing wave voltage. From this, we obtained appropriate directional values for the required work. As we know that the directivity is directly proportional to the gain, this leads to obtaining a high gain amount and thus achieving high performance for the antenna. We conclude from this that the voltage of the standing wave the input impedance is related to the results of the return loss. When the results are good, this leads to obtaining a compatibility between the two input impedances and the source impedance, and no standing waves are formed and the largest possible amount of energy is transferred, meaning the amount of energy wasted is small, which in turn gives a high gain to the antenna and then neglects the antenna with high efficiency and good performance.

References

[1] P.S. Hall, Y.Hao, “Antennas and propagation for body-centric wireless communications. Artech house”, 2012.

[2] Z. Ning Chen, W. Kian Toh, X. Qing,“A microstrip patch antenna with broadened beamwidth. Microwave and optical technology letters”, 50(7) (2008)1885-1888.

[3] S. Gnanamurugan, B. Narmadha, A. Shamina, “Gain and Directivity Enhancement of Rectangular Microstrip Patch Antenna using HFSS. Asian Journal of Applied Science and Technology”, Vol. 1, No. 2, pp.(2017) 127–131.

[4] PR. Imtiyajkhan, “Microstrip Patch Antenna design for Telemedicine Application. Ms.c. Thesis” , p. 51,(2014).

[5] K. Fazel, S. Kaiser,“ Multi-carrier and spread spectrum systems: from OFDM and MC-CDMA to LTE and WiMAX. John Wiley & Sons” ,(2008).

[6] J.M. Patel, S.K. Patel, F.N. Thakkar, “Comparative analysis of S-shaped multiband microstrip patch antenna” 2(7)(2013) 3273-3280.

[7] K.O. Odeyemi, D.O. Akande, E.O. Ogunti, “Design of an S-band rectangular microstrip patch antenna. European Journal of Scientific Research”, 55(1)(2011) 72-79.

[8] A. Pandey, “Practical microstrip and printed antenna design”, (2019).

[9] S.Y. Liao, “Microwave devices and circuits”, (1990).

[10] K.Deng, M.Ma, “The study and implementation of meander-line antenna for an integrated transceiver design”,(2010).