Design Of A 2.4 Ghz Microstrip Patch Antenna For Wifi Communication Using Cst Studio Suite 2019

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***Abstract*— In this era of modern communication, there is a need for antennas that are lightweight, affordable, and easy to install. Many transmission devices require antennas with these specifications, and those specifications can be found in microstrip antennas. This antenna is commonly used in satellite communication, radar communication, military applications, and smartphones. However, the weakness of the microstrip antenna is its low gain, which is only about 5 dB. The design of the microstrip antenna is carried out using three methods: simulation, measurement, and fabrication. In this research, a microstrip patch antenna is designed to operate at a frequency of 2.4 GHz. The desired specifications are as follows: VSWR ≤ 2, return loss ≤ -10 dB. In the realization process, FR-4 substrate material with a thickness of 1.6 mm was used. At the end of the research process, a comparison was made between the simulation results and the measurement results. The simulation results from the antenna show that the VSWR is 1.545 with a return loss of -13.380 dB.**

***Keywords*— Antenna Mikrostrip; Frekuensi 2.4 GHz; VSWR; Return Loss.**

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I. Introduction

An antenna (or aerial) is a device that functions to radiate or receive radio waves. (Dian Rahmanda : 2016). An antenna transfers electromagnetic wave energy from a cable medium to the air or vice versa, from the air to a cable medium. Microstrip antennas have advantages such as their small size and simplicity. The antenna is commonly used in satellite communication, radar communication, military applications, and smartphones. Microstrip antennas can be used for 4G or 5G networks.

In wireless communication systems, the role of antennas is essential in the process of transmitting data to and from the air. Because with an antenna, electromagnetic waves can be transmitted and received. One of the wireless communications is the *Wireless Local Area Network (WLAN).* To support *WLAN* technology, this antenna must be small and capable of operating in the *Wi-Fi* frequency band. Since the strength of wireless signals is generally not uniform in every location, and not all areas are well covered, we need to place several antennas to cover all areas so that the *Wi-Fi* signal can be accessed. However, the size and cost of providing the antenna become considerations. Therefore, a small-sized antenna is used that is inexpensive but has good capabilities and is easy to integrate with other equipment. The microstrip antenna is a candidate that can meet those needs. This is because microstrip antennas can operate at high frequencies, with small dimensions, lightweight, and are easy to integrate with other equipment. The main role of antennas operating in the 2.4 GHz frequency range. This frequency has been widely used around the world because the 2.4 GHz frequency is the standard for the *IEEE* 802.11b protocol *for wireless fidelity (wifi).*

Wi-Fi is a *WLAN* technology used in limited coverage areas, such as campuses or offices. The better the quality of the antenna, the better the quality of the information received. The designed antenna is a single-element rectangular microstrip *patch* antenna using CST Studio Suite 2019 software.

The substrate element functions as the dielectric material of the microstrip antenna, separating the radiating elements from the grounding elements. This element has various types that can be classified based on the relative permittivity (εr) and thickness. (h). Both values influence the operating frequency, bandwidth, and also the efficiency of the antenna that will be created. The thickness of the substrate is much greater than the thickness of the radiation metal. The thicker the substrate, the greater the bandwidth will increase, but it will affect the emergence of surface waves. (surface wave).

The ground plane serves as the grounding for the microstrip antenna system. This grounding element generally has the same type of material as the radiation element, which is copper metal.

II. METHOD

A. Tools and Materials

The tools needed include a computer or laptop equipped with CST STUDIO SUITE 2019 software to assist in the design of the antenna before fabrication. The materials used for fabrication are PCB, connectors, and some other solvent materials.

B. Antenna Specifications

The antenna to be designed in this Final Project is a microstrip patch antenna. This antenna operates by receiving and transmitting electromagnetic waves at a frequency of 2.4 GHz. The designed microstrip antenna must have a VSWR of less than 2. The design and simulation are carried out using the CST Studio Suite 2019 software application. Here are the specifications for the microstrip antenna that will be designed.

TABLE I
ANTENNA SPECIFICATIONS

Specifications	Value
Work Frequency	2.4 GHz
VSWR	≤ 2
Return loss	≤ -10 dB
Gain	3 dB
Impedance	50 Ω

Metamaterial-based microstrip patch antenna using an FR-4 substrate, with a substrate thickness (h) of 1.6. FR-4 is chosen because it is easy to manufacture, cost-effective, and has a small size.

C. Antenna Design

In the first stage, the design of the microstrip patch antenna at a frequency of 2.4 GHz is carried out as shown in the following image. This is then followed by the next stage.

TABLE 2
ANTENNA PARAMETER

Parameter	Value (mm)	Information
Width of substrate	65	W
Length of substrate	65	L
Height of substrate	1.6	h
Width of patch	36	Wp
Length of patch	28.68	Lp
Height of ground / patch	0.035	g
Width of feedline	1.444	wf

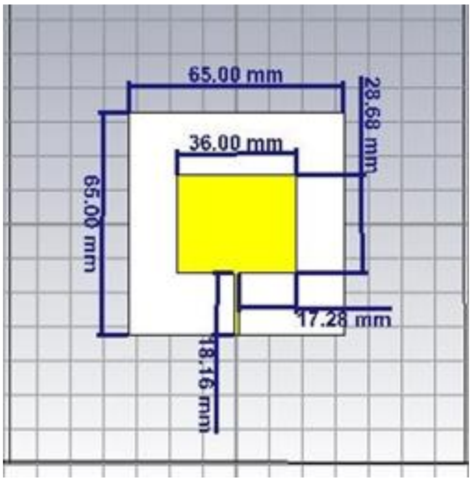

Fig. 1 Antenna Patch Mikrostrip

III. RESULTS AND DISCUSSION

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A. Design in CST

In the process of simulating a microstrip patch antenna at a frequency of 2.4 GHz, the calculation of the antenna's dimensional parameters discussed in the previous section will be simulated using CST STUDIO SUITE 2019 software. After the simulation results of the antenna, parameters such as VSWR, return loss, radiation pattern, and gain will be obtained.

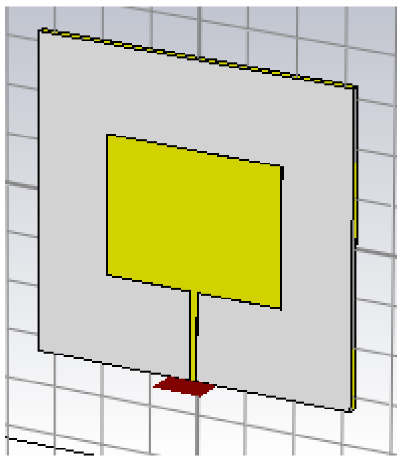
Fig. 2 Front View Antenna Design (Patch)

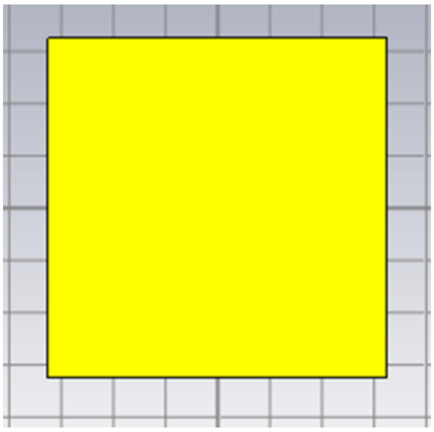

Fig. 3 Design of the Antenna from the Rear View (Ground)

B. *Fabrication Results*

The fabricated antenna is made from FR-4 substrate material, with a thickness of h = 1.6 mm and a female SMA connector. The fabrication of the metamaterial patch antenna can be seen in the image below.

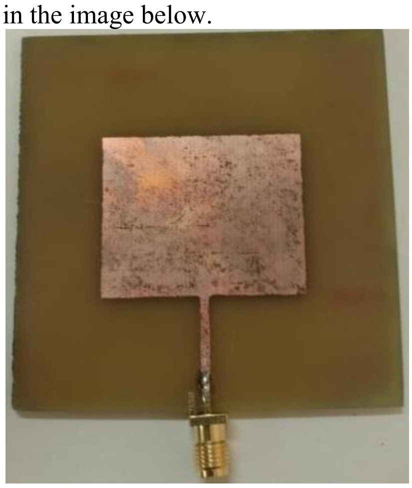

Fig. 4 Front View

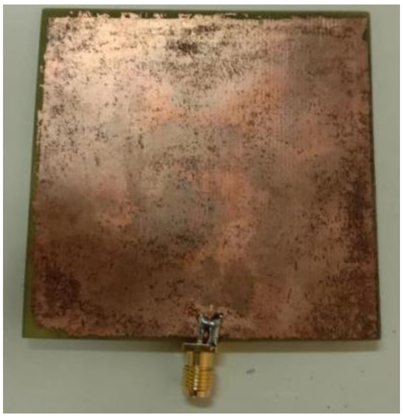

Fig. 5 Back View

C. *Measurement Return Loss / S - Parameters*

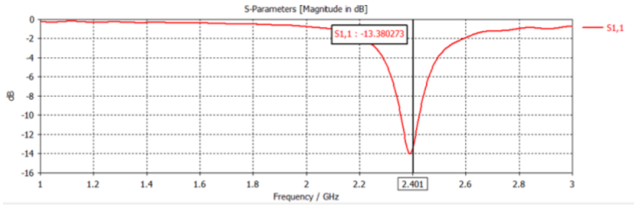

Fig. 6 Results of S-Parameters Simulation

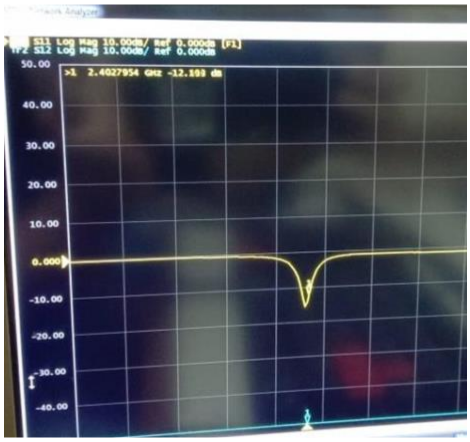

Fig. 7 Results of S-Parameters Measurement

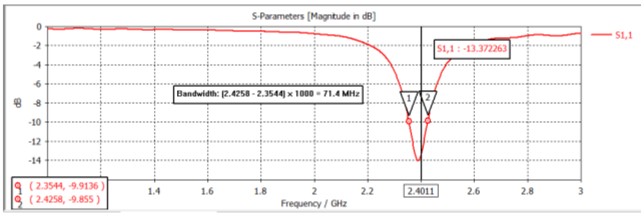

Fig. 8 Bandwidth from Simulation Results

An analysis was conducted to compare the results of the simulation with the measurements taken. The return loss value of an antenna is the ratio of the power reflected back to the power transmitted. Bandwidth is the operating frequency range of an antenna, limited by two frequencies with a certain return loss value according to the function of the antenna. In the simulation, the return loss value is -13.380 dB and the bandwidth is 71.4 MHz. Measurement results show a return loss value of -12.193 dB. The return loss read on the antenna has met the desired parameter standards (≤ -10 dB) for the antenna to be realized.

D. *Measurement of VSWR*

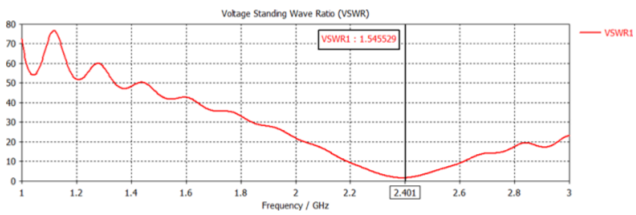

Fig. 9 Results of VSWR Simulation

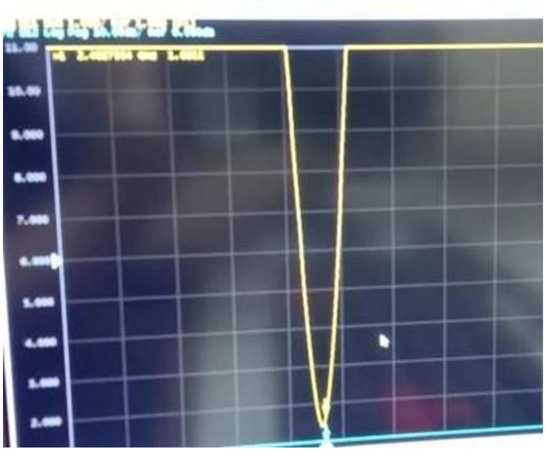

Fig. 10 Results of VSWR Measurement

For the simulation results, the VSWR at a frequency of 2.4 GHz is 1.5455, while the measured value is 1.6. The VSWR reading on the antenna meets the desired parameter standard (≤ 2) for the antenna to be realized.

E. Measurement of Gain

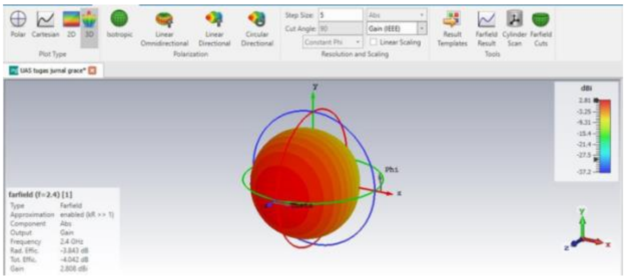

Fig. 11 Simulation Results of Gain

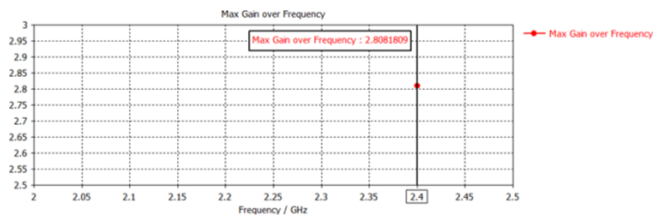

Fig. 12 Simulation Results of Gain

Gain refers to the ability of an antenna to enhance the strength of the signal received from a specific direction. Based on the simulation results, the gain obtained is 2.808 dBi.

F. Measurement of Radiation Patterns

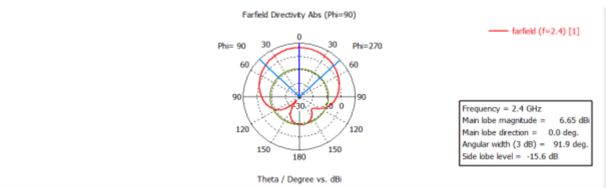

Fig. 13 Results of Radiation Pattern Simulation

Based on the image above, it can be seen that the radiation pattern obtained is a unidirectional radiation pattern, emitting in only one direction.

IV. Conclusion

The designed microstrip antenna is a microstrip patch antenna with a working frequency of 2.4 GHz. The simulation results of the antenna show a VSWR and return loss at the center frequency of 2.4 GHz of 1.545 and -13.380 dB, respectively. The bandwidth of the microstrip patch antenna is 71.4 MHz within the frequency range of 2.35 – 2.42 GHz, and the gain of the microstrip patch antenna is 2.808 dB. Meanwhile, the measured VSWR and return loss are 1.6 and -12.193 dB, respectively. The VSWR and return loss parameters have met the antenna specifications. The measurement results of all parameters differ significantly from the simulation results. This is due to the shape and size of the antennas being less precise, the measurements being taken in a non-ideal location, the accuracy of the measuring devices, and interference from the surrounding environment. During the measurement, the antenna will be exposed to an environment that differs from the simulated one. Environmental disturbances, such as reflections from surrounding objects, electromagnetic noise, and atmospheric effects, can lead to discrepancies between the simulation results and the measurement results.

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