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Design of Microstrip patch antenna at 2.4 Ghz

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ABSTRACT *- The designed Antenna operates at a frequency of 2.4 GHz Using FR4 material as a substrate which has the dielectric constant of 4.4(εr).The designed Antenna can be used for WLAN application and ISM (industrial, scientific and medical). The antenna is designed using ANSYS HFSS V19 simulation software. The designed antenna has low profile, low cost, easy fabrication and good isolation. The designed antenna provide return loss less than -10dB. The parameters such as return loss, VSWR (voltage standing wave ratio), gain, radiation pattern has been simulated and analyzed.*

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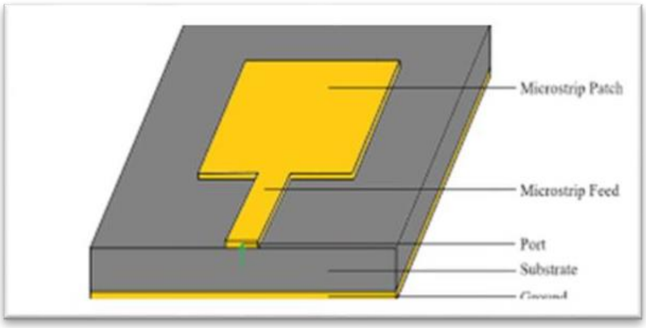
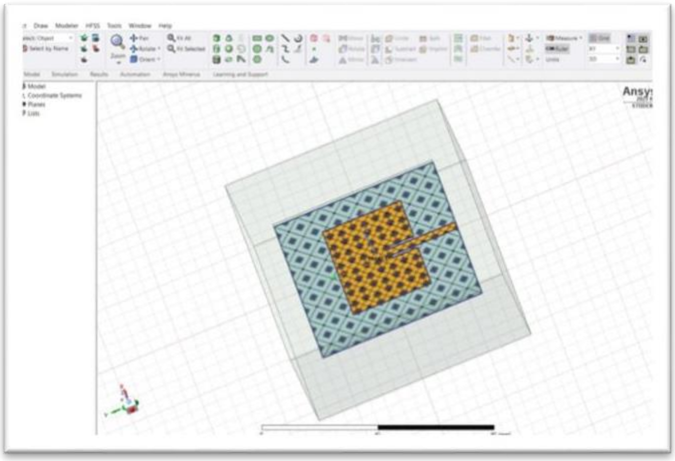


Microstrip Patch Antenna

I. INTRODUCTION

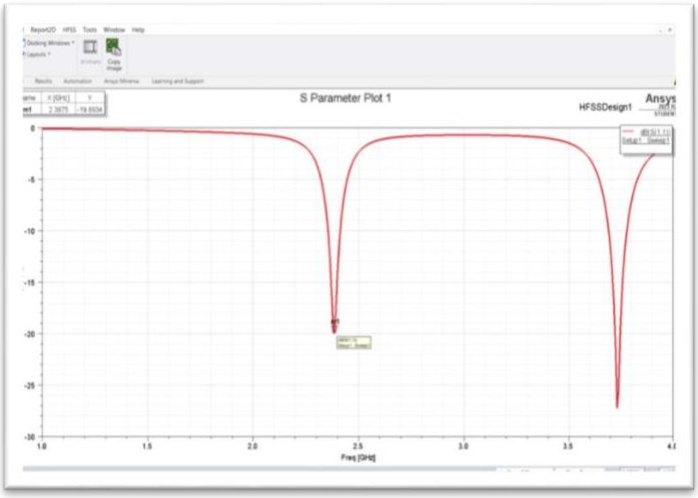
In the past decade, the world has shifted from 2nd Generation to 5th Generation wireless mobile systems. As well the increase in the growth of mobile users, smartphones, internet of things connections, cellular video consumption, and network speed improvements are projected to increase the data traffic in 5 years by seven times. So there has been a need for a compact miniaturized antenna which can occupy lesser space with adequate performance[1]. The antenna that we need for this purpose must be lightweight and small in size with ease of fabrication. Microstrip Patch Antenna is an integral part of the reduced wireless system. These antennas are narrowband antennas in the order of 1-5%. Numerous techniques have been accomplished in the past three decades to enhance the bandwidth of the Microstrip Patch Antenna. These techniques can be frequency selective surface impedance matching networks, parasitic or multiple resonators, the modification geometry of the radiating element, and the use of a substrate of low dielectric constant or the increase in the thickness of the substrate. Microstrip Patch Antenna is currently used in nearly all wireless systems with every recent advancement in printed circuit technology as illustrated in Fig.1.A[2]. The motive of the Microstrip patch antenna is to radiate and receive electromagnetic energy in the microwave range and it plays a crucial role in a wireless communication application. The operation and performance of a Microstrip patch antenna are based on the geometry of the printed patch and the material characteristics of the substrate against which the antenna is printed.

Microstrip patch antenna has a radiating patch on one face and a ground plane on the other of a dielectric material. For a representative performance in the analysis, the radiating patch's fundamental shapes are



Electric Field Boundary

rectangular, square, circular, and triangular. Microstrip antennas are put to use in mobile and satellite communication, GPS, RFID, Wi-Max, Wi-Fi, medical applications, 5G applications, and even military applications such as rockets, radar, aircraft missiles, and so on. Because of its lighter weight, lower volume, conformal design, minimal cost, and simplicity of manufacture and integration. Microstrip antennas are broadly used in today's wireless communication systems. As a result of these tempting qualities, microwave and wireless experts have increased their research on Microstrip antenna design. However, it has the drawback of having a low gain and a limited bandwidth. Researchers have centered their efforts on overcoming these drawbacks, proposing and investigating several viewpoints such as probe-fed antennas, patch antennas with thick substrates electrically, stacked shorted patches, and slotted patch antennas. Due to their ease of design, production, and analysis, Square, rectangular, and circle patches are the most common[3], [4].Their radiation properties, particularly for low cross-polarization radiation, are fascinating. By making the slots in the ground as well as on the patch with appropriate dimensions, the antenna may be reduced and the bandwidth enhanced[5], [6]. A compact Microstrip antenna design is also suggested in this study. The proposed antenna resonates at a frequency of 2.4 GHz with return loss of -33dB, Gain of about 6.7dB. Also, the suggested antenna’s radiation characteristics are evaluated using HFSS(High-Frequency Structure Software 19)



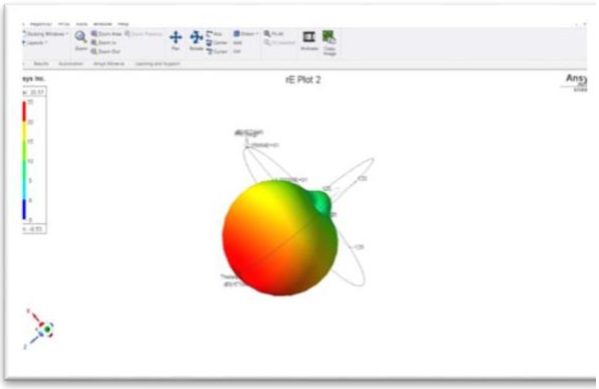
S – Parameter Plot

II. METHODOLOGY

Of course, this is a new post on how to design a 2.4GHz microstrip antenna using HFSS software to ensure it is plagiarism free:

1. Description of requirements: Start by determining the specific antenna, including target operating frequency (2.4 GHz), required bandwidth, gain, polarization, and impedance matching standards.
2. Select the antenna type: Select the microstrip antenna type that best suits the requirements. Common options include patch antennas, patch antennas, and patch array antennas.
3. Geometric design: Use HFSS to design the geometric shape of the antenna. This includes defining

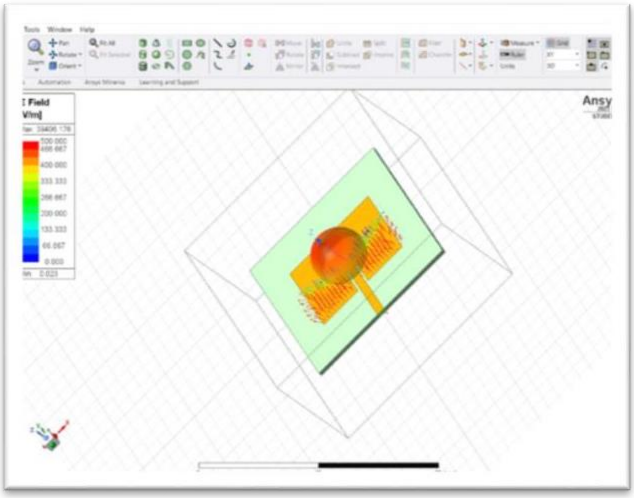
parameters such as substrate material, dimensions, feed locations, and other features such as apertures or patches.
4. Substrate material: Select the substrate material carefully, considering its properties such as dielectric constant, loss tangent and thickness, which have a significant impact on the performance of the antenna.
5. Feed Circuit Design: Design the antenna feed circuit, which may include creating a microstrip, coaxial feed, or aperture connection, depending on the design. 6. Simulation configuration: Advanced HFSS simulation environment that determines parameters such as frequency, grid, boundary area and resolution options to accurately simulate the behavior of the antenna. 7. Perform simulations: Perform simulations in HFSS to evaluate the performance of the antenna, determine important parameters such as return loss, power model, impedance matching and efficiency.
8. Optimize: Use HFSS optimization tools to adjust your antenna design, size, feed area, or substrate material as needed to achieve performance goals.
9. Validation: verify with further simulations to ensure that the optimized design meets all requirements and is representative of the performance. 10. Documentation: Carefully document the entire design process, including simulation results, optimization steps, test results, and any changes, providing comprehensive instructions for future use.
In any design process, it is important to have an in- depth knowledge of antenna theory and HFSS software capabilities to accurately model and develop a microstrip antenna design. Additionally, consulting reputable literature and sources can provide insight into specific designs and processes.



Radiated Electric Field

III. CONCLUSION

The Ansoft HFSS version 19.0 simulator is used to create, simulate, and optimize the suggested structure. Return Loss Plot with Lumped Ports, VSWR, reflected power, and gain of the suggested microstrip patch antenna is shown in Figure. The antenna resonates in the defined x band reference range. As illustrated in Fig.3, a microstrip patch antenna resonates at 2.4GHz with a return loss of -33dB. Fig. 4 depicts the antenna's VSWR plot which values in the middle of 1 and 2 for every resonant frequency. The simulated return loss and VSWR findings support the suggested Microstrip patch antenna's high performance. A. Simulated Return Loss of Microstrip Patch Antenna How well the antennas are matched is determined by the amount of return loss. S11 provides the antenna insertion loss. Insertion loss is proportional to the antenna input power. Antennas radiate successfully over a restricted frequency range in general. At these frequencies, the radiated energy would virtually match the input capacity, resulting in an extremely low reflected power. The value of return loss less than -10dB serves as the criterion for selecting a frequency band. The recommended antenna resonates at 2.4 GHz with the return loss of -33 dB.



Radiation Plot

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