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HLBN Microstriata Antenna

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ABSTRACT: *Microstriata antennas are widely used in modern wireless communication systems due to theircompact size, low profile structure, light weight and ease of fabrication.The dual band Microsinta antenna operates at two distinct frequency bands such as 2.4 GHz and 5 GHz. The antenna consists of a radiating patch, dielectric substrate and ground plane. HFSS (High Frequency Structure Simulator) software is used for accurate electromagnetic simulation. Performance parameters such as Return Loss (S11), VSWR, Gain, Bandwidth, Radiation Pattern and Efficiency are analyzed in detail. The antenna design is based on transmission line model equations and electromagnetic field theory. Proper impedance matching ensures maximum power transfer and efficient radiation characteristics. Simulation results demonstrate that the proposed antenna achieves good impedance matching at the desired frequency with acceptable bandwidth and radiation characteristics. The radiation pattern exhibits broadside characteristics, making it suitable for applications such as WLAN, Wi-Fi, Bluetooth, satellite communication, and other RF systems.The study confirms that microstrip patch antennas provide an effective solution for compact and portable communication devices, and further performance enhancement can be achieved through techniques such as slotting, stacking, and the use of different feeding methods*
Keywords: *Microstrip Patch Antenna, HFSS, Return Loss, VSWR, Gain, Wireless Communication.*

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I. INTRODUCTION

Wireless communication is the fastest growing field of technology which has captured the attention of social life in the present century. Modern wireless local area networks are implemented in many homes, business centers and campuses. The first well-known antenna experiment was conducted by the Heinrich Rudolf Hertz in 1886, which consisted of the dipole antenna is also called the Hertz (dipole) antenna.

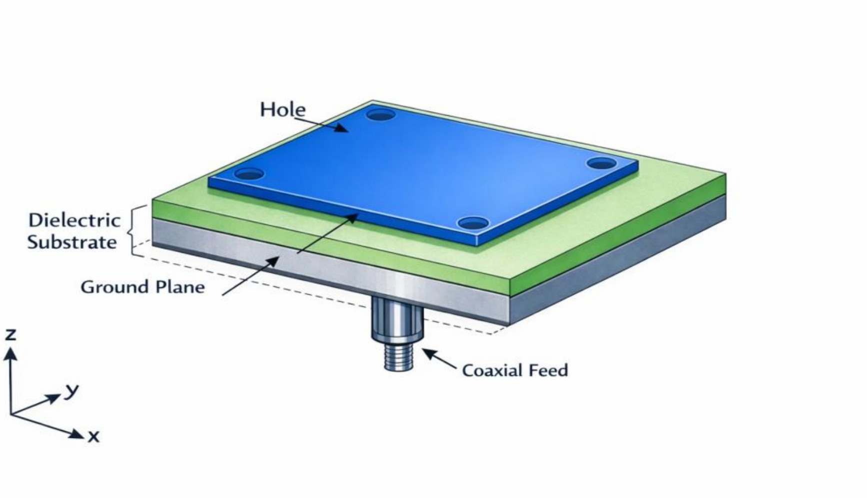
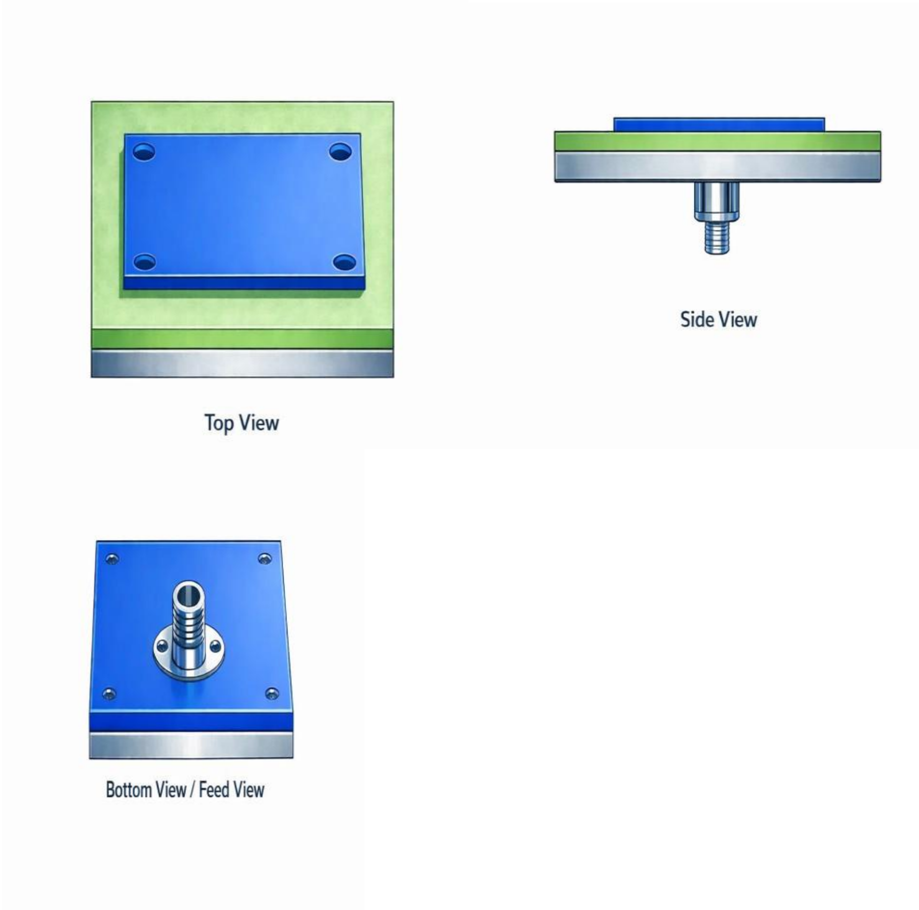


Figure 1. Structure of Microstriata Antenna

Then Guglielmo Marconi developed and commercialized wireless technology by introducing a radiotelegraph system, where he used Monopole antennas (near quarter- wavelength).manuscript .The concept of microstrip antenna was first proposed by Deschamps in 1953.However, practical implementation of this concept of Microsinta antennas was not achieved until late 1970s, by Munson and Howell . A conventional microstrip antenna in general consists of a conducting patch printed grounded microwave substrate with ground plane below, as shown in. figure 1. Microsinta antennas have attractive attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts. A Microstrip device literally means a sandwich of two parallel conducting layers separated by single thin dielectric substrate. The lower conductor is called Ground Plane & the upper conductor is a simple resonant circular/rectangular Patch. The metallic patch (usually Cu or Au) may take many geometrics viz. rectangular, circular, triangular, elliptical, helical, ring etc.The Microsinta antenna is commonly excited using a microstrip edge feed or a coaxial probe. The canonical forms of the Microsinta antenna are the rectangular and circular patct MSAs. The rectangular patch antenna in is fed using a microstrip edge feed and the circular patch antenna isfed using a coaxial probe. The dielectric substrates are used.

- Their is different types of views of Antenna structure are



II. LITERATURE SURVEY

Microstrip (Microsinta) patch antennas have become one of the most widely used antennas in modern wireless communication systems due to their low profile, lightweight structure, low fabrication cost, and ease of integration with microwave circuits. They are widely used in applications such as Wi-Fi, WLAN, satellite communication, radar systems, and mobile communication devices. Researchers commonly use electromagnetic simulation tools such as HFSS (High Frequency Structure Simulator) to design and analyze these antennas before fabrication. Early research focused on understanding the basic structure and radiation mechanism of microstrip patch antennas. A typical microstrip antenna consists of three main layers:

- Conductive patch
- Dielectric substrate
- Ground plane

These antennas are usually designed in shapes such as rectangular, circular, triangular, or elliptical, and their performance is evaluated using parameters like gain, VSWR, bandwidth, radiation pattern, and return loss However, traditional microstrip antennas suffer from limitations such as narrow bandwidth and relatively low gain, which motivated researchers to develop new techniques such as slotting, partial ground planes, and multi-band designs to improve performance.With the rapid growth of wireless communication, researchers began focusing on compact and miniaturized antenna structures. Compact antennas reduce the overall size of wireless devices while maintaining good radiation characteristics. Recent studies have proposed techniques such as:Slot loading in the patch Defected ground structures (DGS) Metamaterial structures Multi-band antenna designs

These techniques help improve parameters such as bandwidth, impedance matching, and radiation efficiency while reducing antennasize.Psychosocial 4. HFSS-Based Antenna Design and Simulation ANSYS HFSS is one of the most widely used electromagnetic simulation tools for antenna design. It is based on the Finite Element Method (FEM) and allows accurate modeling of high-frequency electromagnetic structures. In many research works, HFSS is used to: Create the 3-D antenna structure Define substrate materials and dielectric properties Apply boundary conditions and excitation ports Analyze antenna performance parameters such as S-parameters, gain, VSWR, and radiation patterns. Science Direct

For example, several studies have designed rectangular microstrip antennas on FR-4 substrates ($\varepsilon r \approx 4.4$, thickness ≈ 1.6 mm) and optimized their dimensions to operate at frequencies such as 2.4 GHz for wireless sensor networks and Wi-Fi applications. Several researchers have investigated the characteristics and performance of microstrip patch antennas in order to improve their efficiency and bandwidth. One of the fundamental references in antenna theory explains the basic operation of microstrip antennas and the methods used to determine their design parameters such as patch length, width, dielectric constant, and substrate thickness. The resonant frequency of a rectangular microstrip patch antenna depends mainly on the physical dimensions of the patch and the dielectric properties of the substrate material. Commonly used substrate materials include FR-4 epoxy, Rogers RT/duroid, and other dielectric materials that provide stable electrical properties at microwave frequencies. Researchers have emphasized that proper selection of substrate material plays a significant role in determining the antenna performance parameters such as gain, bandwidth, and radiation efficiency.

FEEDING TECHNIQUES

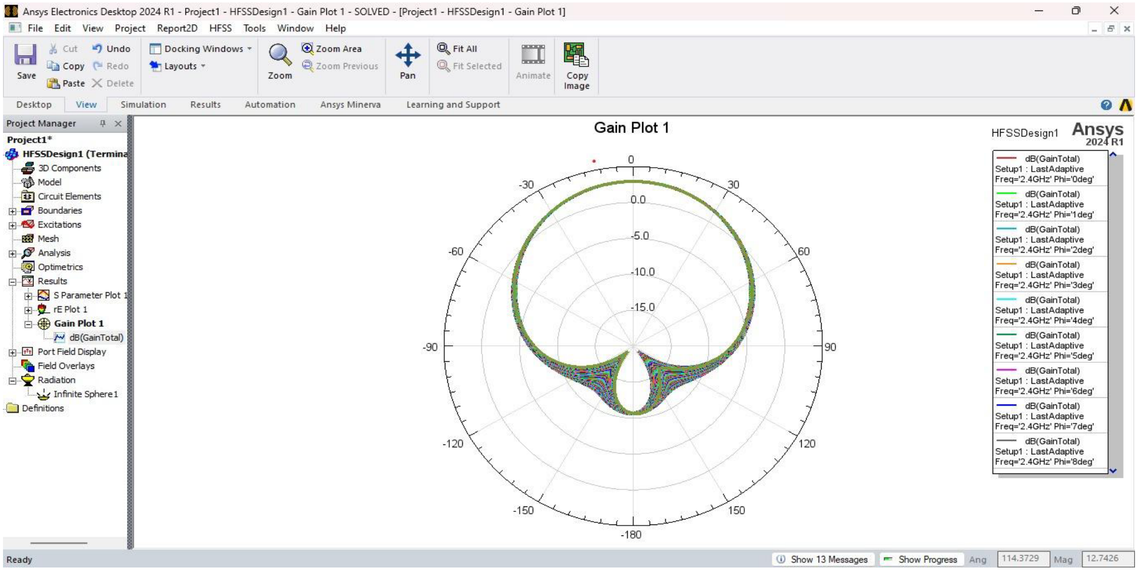
There are variety of feed technique to microstrip patch antennas. These methods can be classified into two categories- contacting and non- contacting. In the contacting method, the RF power is fed directly to the radiating patch using a microstrip line as a connecting element. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the micro trip line and the radiating patch. The feed of microstrip antenna can have many configurations like microstrip line, coaxial, aperture coupling and proximity coupling. But microstrip line and the coaxial feeds are relatively easier to fabricate. Coaxial probe feed is used because it is easy to use and the input impedance of the coaxial cable in general is 50 ohm. There are several points on the patch which have 50 ohm impedance. We have to find out those points and match them with the input impedance. Comparison of the different feeding techniques

PARAMETERS

Different parameter such as VSWR, Return Loss, Antenna Gain, Directivity, Antenna Efficiency and Bandwidth are analyzed

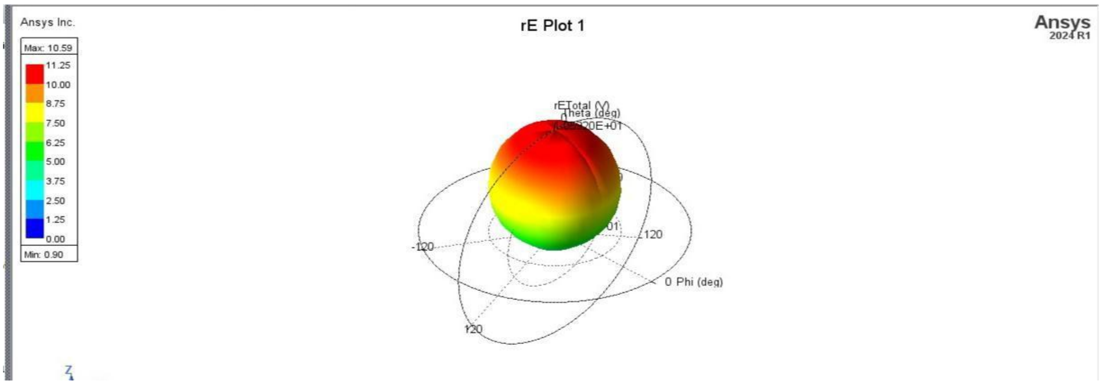
- **Gain**

Gain is the parameter which measures the degree of the directivity of the antenna's radiation pattern. It is defined as the ratio of the radiated power Pr to the input power Pi. The input power is transformed into radiated power and surface wave power while a small portion is dissipated due to conductor and dielectric losses of the materials used. Antenna gain can also be specified using the total efficiency instead of the radiation efficiency only. This total efficiency is a combination of the radiation efficiency and efficiency linked to the impedance matching of the antenna. High gain antenna have the advantage of longer range and better signal quality but must be aimed carefully in particular direction.



- **Radiation**

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.

- **VSWR**

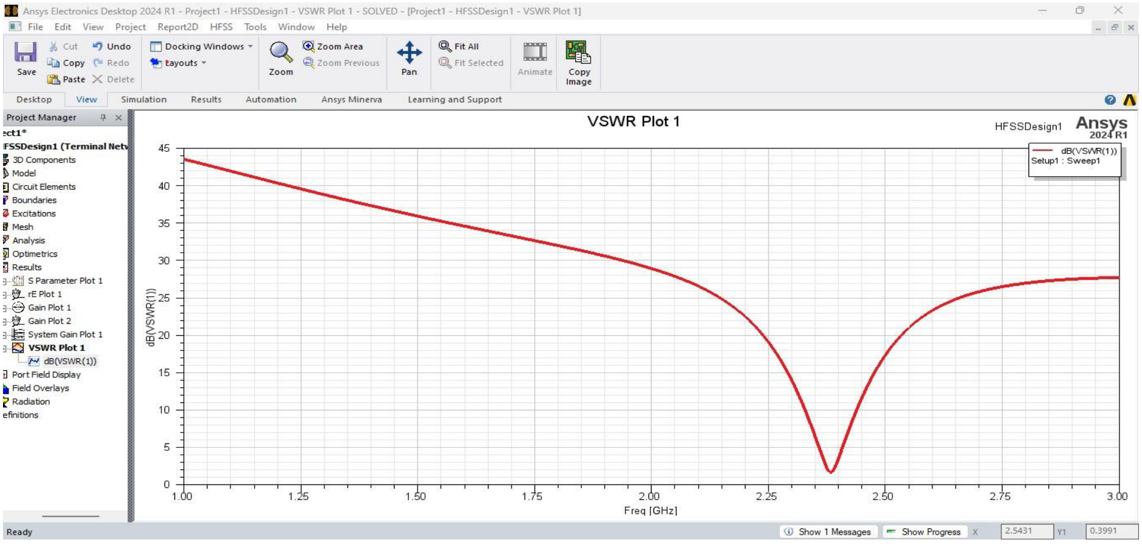
Voltage standing wave ratio is defined as VSWR=Vmax/Vmin.It should lie between 1 and 2. VSWR is defined as the ratio of the maximum voltage to the minimum voltage in a stading wave pattern. A standing wave developed when power is reflected from a load. This happens because of power would be reflected back, whereas a Γ = 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

To design a rectangular microstrip patch antenna following parameters such as dielectric constant (€r), resonant frequency (fo), and height (h) are considered for calculating

Microstrip Patch Antenna Design Equations

- Width of the Patch $W = \frac{c}{2f_r}\sqrt{\frac{2}{(\ni r+1)}}$ - - - equation (1)



Where

W = Width of patch

c = Speed of light (3 × 10^8 m/s)

fr = Resonant frequency

εr = Dielectric constant of substrate.

- Effective Dielectric Constant

$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+\frac{12h}{w}}}$ d. ---equation (2)

Where

εeff = Effective dielectric constant

h = Height of substrate

- Effective Length of Patch

Leff = $\frac{c}{2f_r\sqrt{\epsilon_{eff}}}$ ------ equation (3)

Where

Leff = Effective length of patch

- Length Extension (Fringing Effect)

$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\epsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$ -- equation (4)

Where

ΔL = Length extension due to fringing fields

- Actual Length of Patch

L = Leff − 2ΔL ----- equation (5)

Where

L = Actual length of the patch

- Ground plane length

Lg= L + 6h ------ equation (6)

Where

Lg = Ground plane length

- Ground Plane Width

Wg = W + 6h ------ equation (7)

Where

Wg = Ground plane width

- Reflection Coefficient

Γ = $\frac{(zl-z0)}{(zl+z0)}$------ equation (8)

Where

ZL = Load impedance

Z0 = Characteristic impedance

- Voltage Standing Wave Ratio (VSWR)

$$\text{VSWR} = \frac{((1 + |\Gamma|)}{(1 - |\Gamma|)} \text{ - - - - - - equation (9)}$$

- Return Loss

$$\text{Return Loss (dB)} = -20 \log 10 |\Gamma| \text{ - - - equation(10)}$$

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IV. CONCLUSION

In this paper, we have proposed a design of a cross-shaped microstrip patch antenna at the operating frequency of 2 GHz to address the drawback of microstrip antennas using a cross shaped aperture in terms of low gain. A dual-band has been exhibited by inserting a cut-off in the ground plane structure and results were plotted out. From the analysis of results obtained for different parameters of the antenna, it has been noted that the cross shaped patch antenna exhibits good performance in term of gain, directivity and radiation efficiency. However, this is obtained at the expense of higher return loss as compared to the reference antenna. And we must note that many aspects affect the performance of a microstrip patch antenna such as the dimensions, the choice of the substrate, the feeding techniques and also the operating frequency can be a major factor on the antenna's output.

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