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Design And Development Of Simple Rectangular Microstrip Antenna For Wideband Applications: A Review

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Abstract: This paper presents a comprehensive review of rectangular dipole microstrip antennas (RDMAs) for wideband applications. RDMAs have gained significant attention in recent years due to their compact size, low profile, and ease of integration with other components. The paper discusses the design considerations, theoretical background, and wideband techniques used to improve the performance of RDMAs. Various techniques, including defected ground structure, slotted patch, multi-layered structure, and parasitic elements, are reviewed. The paper also highlights the advantages and applications of RDMAs in wideband systems, including wireless communication systems, radar systems, and satellite communication systems. The review aims to provide a comprehensive understanding of RDMAs and their potential for wideband applications.

***Index Terms* -** RDMAs, DGS, HFSS, Wideband Antenna, Microstrip Antenna, Slotted Patch.

I. INTRODUCTION

Microstrip antennas have gained popularity in recent years due to their compact size, low profile, and ease of integration with other components. Among various types of microstrip antennas, rectangular dipole microstrip antennas (RDMAs) have attracted significant attention for their potential in wideband applications. This paper reviews the design and development of RDMAs for wideband applications. An antenna or aerial in radio engineering is a specialized transducer, designed by an array of conductors which are connected electrically to the transmitter or receiver[2]. The main function of an antenna is to transmit & receive radio waves equally within all horizontal directions Antennas are available in different types and shapes. The small antennas can be found on the roof of homes to watch TV and big antennas capture signals from different satellites which are away millions of miles. Antennas move vertically & horizontally to capture & transmit the signal. There are different types of antennas available like aperture, wire, lens, reflector, microstrip, log periodic, array, and many more. This article discusses an overview of microstrip antenna[1].

An antenna that is shaped by simply etching out a piece of conductive material above a dielectric surface is called a microstrip antenna or a patch antenna. On the ground plane of this microstrip antenna, the dielectric material is mounted, where this plane supports the entire structure. In addition, the excitation to this antenna can be provided with feed lines that are connected to the patch. Generally, these antennas are considered low-profile antennas that are used in microwave frequency applications that have above 100 MHz frequency. Antenna's micro-strip/patch can be selected to be rectangular, square, elliptical & circular for ease of analysis and fabrication. Some microstrip antennas do not utilize a dielectric substrate but they are made with a metal patch that is mounted on a ground plane with dielectric spacers; thus the resulting formation is less strong but its bandwidth is wider[3][4].

II.MICROSTRIP ANTENNA CONSTRUCTION

Microstrip antenna design can be done with the help of an extremely thin metallic strip by arranging it on a ground plane in between a dielectric material. Here, the dielectric material is a substrate used for separating the strip from the ground plane. Once this antenna is excited, then the generated waves in the di-electric undergo reflections & the energy emitted from the metal patch edges is very low. These antenna shapes are identified by the metallic patch shape arranged on the dielectric material[6].

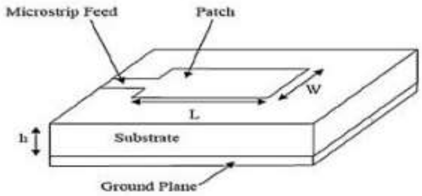

Fig1: Construction of Microstrip Antenna

Generally, the strip/patch & the feed lines are photo-etched on the surface of the substrate. There are different microstrip antenna shapes like square, dipole, rectangular, circular, elliptical, and dipole. We know that patches can be formed in various shapes but, because of the easy in fabrication, circular, square & rectangular shaped patches are normally used[7]. Microstrip antennas can also be formed with a group of various patches above a dielectric substrate. Either single or numerous feed lines are utilized to give excitation to the microstrip antenna. So the presence of microstrip element arrays provides better directivity, high gain, and increased range of transmission with low interference.

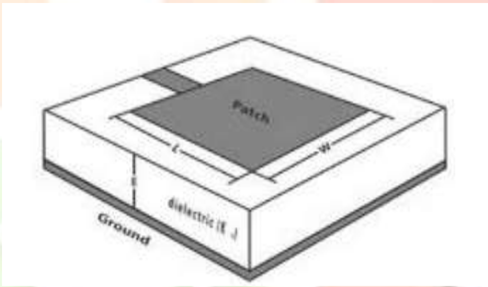

Fig2: Construction of Patch Antenna

A microstrip antenna works as; whenever current throughout a feed line arrives at the microstrip antenna's strip, then electromagnetic waves are produced. So these waves from the patch will start radiating from the width side. However, when the strip thickness is very small, the waves produced in the substrate will get reflected through the strip edge. The constant strip structure along the length does not allow radiation emission[10].

The microstrip antenna's low radiating capability allows for covering only wave transmissions with small distances like stores, indoor locations, or local offices. So this inefficient wave transmission is not acceptable in a centralized locality in a very large area. Usually, hemispherical coverage is given by a patch antenna at a 30º – 180º angle at a distance from the mount[9].

III. FEEDING METHODS OF MICROSTRIP ANTENNA

The microstrip antenna has two feeding methods; contacting feed and noncontacting feed which are discussed below.

Contacting Feed

The power in contacting feed is provided directly to the radiating element. So this can be done with a coaxial line/microstrip. This type of feeding method is again classified into two types; Microstrip feed and coaxial feed which are discussed below.

Microstrip Feed

Microstrip feed is a conducting strip with a very small width than the radiating element's width. The feed line provides simple etching above the substrate because of the strip has thinner dimensions. The benefit of this type of feed arrangement is; that the feed can be etched on top of a similar substrate to offer a planar structure.

The feed line toward the structure is provided either at the middle, offset, or inset. The main purpose of the inset cut within the patch is to match the impedance of the feed line' to the patch without requiring any extra matching element.

Coaxial Feed

This feeding method is the most frequently used type and is a non-planar feeding method where z co-axial cable is used for feeding the patch. This feeding method is given to the microstrip antenna in such a way that the inside conductor is directly connected to the patch whereas the external conductor is connected to the ground plane.

The impedance will change with the difference in the arrangement of the coaxial feed. Once the feed line is connected anyplace in the patch thus helps impedance matching. However, the feed line connecting throughout the ground plane is a bit hard because this will need drilling a hole within the substrate. This feeding method is very simple to fabricate & has less spurious radiation. But, its main drawback is that it is connected to a ground plane connector.

Non-contacting Feed

The power is given to the radiating element from the feed line with electromagnetic coupling. These feed methods are available in three types; aperture coupled, proximity coupled, and branch line feed.

Aperture Coupled Feed

The aperture feed technique includes two dielectric substrates like antenna dielectric substrate, & a feed dielectric substrate which are divided simply through a ground plane and have a gap in the middle. The metal patch is located above the substrate of the antenna whereas the ground plane is located on another face of the antenna dielectric. To provide isolation, the feed line and feed dielectric are located on another side of the ground plane.

IV. Literature Review

1. "A Novel Design of Rectangular Microstrip Antenna for Wideband Applications" by R. Garg et al. (2018)

- This paper presents a novel design of rectangular microstrip antenna for wideband applications. a novel design of a rectangular microstrip patch antenna optimized for broad bandwidth and wideband applications. The design aims to enhance the antenna's bandwidth and operating frequency range, making it suitable for various communication and sensing applications. This could be achieved through techniques like incorporating slots, shorting pins, or modified ground planes to extend the operating frequency range and improve impedance matching.

2. "Design and Analysis of Rectangular Microstrip Patch Antenna for Wireless Applications" by A. K. Singh et al. (2019)

- This paper discusses the design and analysis of rectangular microstrip patch antenna for wireless applications. focuses on designing and analyzing rectangular microstrip patch antennas for various wireless communication systems. The research investigates the antenna's performance parameters such as bandwidth, efficiency, and return loss, and explores how different design parameters affect these characteristics.

3. "Wideband Rectangular Microstrip Patch Antenna Using Defected Ground Structure" by S. S. Mohan et al. (2020)

- This paper presents a wideband rectangular microstrip patch antenna using defected ground structure. The 2020 paper by S. S. Mohan et al. discusses the use of defected ground structures (DGS) to enhance the bandwidth of a rectangular microstrip patch antenna. By strategically introducing defects in the ground plane, the antenna's operating frequency range can be expanded, making it suitable for applications requiring wider bandwidths.

4. "Rectangular Microstrip Patch Antenna with Slotted Ground Plane for Wideband Applications" by P. Kumar et al. (2019)

- This paper discusses a rectangular microstrip patch antenna with slotted ground plane for wideband applications. explores a method for enhancing the bandwidth of a rectangular microstrip patch antenna by incorporating slots in the ground plane. This design utilizes a quad-slotted ground plane to achieve wider frequency coverage compared to traditional rectangular patch antennas.

5. "Microstrip Log-Periodic Dipole Antenna Analysis with Different Substrates" by Y. Li et al. (2018)
- This paper analyzes microstrip log-periodic dipole antennas with different substrates. explores the design and analysis of a microstrip log-periodic dipole antenna (MLPDA) using different substrate materials. The research focuses on the antenna's radiation characteristics, evaluating how various substrate materials affect its performance, particularly its bandwidth and gain. The authors likely used simulation and potentially experimental verification to compare the antenna's performance when fabricated on different substrates.

6. "Gain Enhancement of Rectangular Microstrip Patch Antenna Using Metamaterial" by S. K. Singh et al. (2020)
- This paper presents a technique to enhance the gain of rectangular microstrip patch antenna using metamaterial. This project is carried out to design two antennas; one of them is a basic rectangular microstrip patch antenna and the other is the rectangular microstrip patch antenna added with an air gap technique for the main purpose of gain enhancement. Both antennas have been designed using RT5880 substrate because of its low dielectric constant at 2.2 and the permittivity of 0.0009. The proposed antennas were analysed and simulated at the frequency of 2.4GHz for WLAN application using the Computer Simulation Technology (CST) software. In order to increase the antenna's gain performance, a 3 mm air gap thickness was added in between the radiating patch element and the ground layer.

7. "Design of Compact Rectangular Microstrip Patch Antenna for Wireless Applications" by A. K. Verma et al. (2019)
- This paper discusses the design of compact rectangular microstrip patch antenna for wireless applications. focuses on designing and optimizing rectangular microstrip patch antennas for various wireless applications, particularly highlighting improvements in compactness and performance. The research explores techniques like slotting and fractal geometry to enhance bandwidth, gain, and return loss. The design process involves selecting operating frequency, substrate material, and patch dimensions, along with choosing an appropriate feeding strategy.

8. "Wideband Rectangular Dielectric Resonator Antenna for X-Band Applications" by R. K. Chaudhary et al. (2018)
- This paper presents a wideband rectangular dielectric resonator antenna for X-band applications. In this article, the analysis of isolation improvement in cylindrical dielectric resonator antennas (CDRAs) is performed for wideband multiple-input multiple-output (MIMO) applications. The proposed MIMO design consists of a K-shaped microstrip feed network above which the dielectric resonators are placed and an extended semi-circular microstrip at the backside of the antenna attached with the partial ground plane. The exclusive feature of the proposed MIMO antenna includes high isolation in a wide frequency range with significantly less separation between the radiators with good gain. Measured results show that this design offers a below 10 dB impedance bandwidth 138.02% (1.54–8.4 GHz) with greater than 15 dB isolation.

9. "Analysis of Rectangular Microstrip Patch Antenna with Different Feed Techniques" by P. K. Sahu et al. (2019)
- This paper analyzes rectangular microstrip patch antenna with different feed techniques. analyzes a rectangular microstrip patch antenna (RMPA) using different feeding techniques, including microstrip inset line, coaxial probe, and proximity coupled line, with the aim of enhancing its performance, particularly gain and bandwidth. The study, conducted using simulation software like CST and HFSS, reveals that the proximity-coupled feed offers the most directive radiation pattern and maintains higher performance, even with a larger antenna size compared to other techniques. The research also demonstrates improvements in antenna gain and bandwidth when using these feeding methods.

10. "Rectangular Microstrip Patch Antenna for WLAN Applications" by S. S. K. Singh et al. (2020)
- This paper discusses a rectangular microstrip patch antenna for WLAN applications. a type of antenna commonly used in Wireless Local Area Networks (WLANs). These antennas are designed to operate at specific frequencies, often in the 2.4 GHz and 5 GHz bands used for Wi-Fi. The design focuses on achieving good performance characteristics like high gain, wide bandwidth, and efficient radiation.

V. DESIGN CONSIDERATIONS & WIDEBAND TECHNIQUES

Design Considerations

1. Patch size and shape: The size and shape of the patch determine the resonant frequency and bandwidth of the antenna.
2. Feed technique: The feed technique used can significantly impact the antenna's performance, including its bandwidth and radiation pattern.
3. Substrate material: The choice of substrate material affects the antenna's performance, including its bandwidth, efficiency, and radiation pattern.
4. Ground plane: The size and shape of the ground plane can impact the antenna's radiation pattern and bandwidth.

Wideband Techniques

1. Defected ground structure (DGS): DGS involves modifying the ground plane to improve the antenna's bandwidth and radiation pattern.
2. Slotted patch: Introducing slots in the patch can help improve the antenna's bandwidth and radiation pattern.
3. Multi-layered structure: Using multiple layers can help improve the antenna's bandwidth and radiation pattern.
4. Parasitic elements: Adding parasitic elements can help improve the antenna's bandwidth and radiation pattern.

Recent Developments

Recent studies have explored various techniques to improve the bandwidth of RDMAs, including:

1. Use of metamaterials: Metamaterials have been used to design compact and wideband RDMAs.
2. Use of fractal geometries: Fractal geometries have been used to design compact and wideband RDMAs.
3. Use of defected ground structures: DGS has been used to improve the bandwidth and radiation pattern of RDMAs.

Challenges and Future Directions

Despite the advancements in RDMA design, there are still challenges to be addressed, including:

1. Bandwidth enhancement: Further research is needed to improve the bandwidth of RDMAs.
2. Size reduction: Designing compact RDMAs while maintaining their performance is a significant challenge.
3. Integration with other components: Integrating RDMAs with other components, such as amplifiers and filters, is crucial for system-level applications.

The link for software design and analysis, https://www.ansys.com/en-in/products/electronics/ansys-hfss/

CONCLUSION

RDMAs have shown great potential for wideband applications. By using various techniques, such as DGS, slotted patches, and multi-layered structures, researchers have been able to improve the bandwidth and radiation pattern of RDMAs. Further research is needed to address the challenges and improve the performance of RDMAs.

FUTURE SCOPE

The future development of wideband RMPA focuses on overcoming current limitations and meeting next-generation communication needs: Metamaterial and Metasurface Integration: Future designs will likely incorporate artificial materials (metasurfaces) to significantly improve gain and directivity while maintaining a low-profile structure for 5G/6G frequencies.

Reconfigurable Antennas: Future research aims at developing intelligent, frequency-agile, and polarization-agile antennas that can change their operating band dynamically using PIN diodes or varactor diodes. MIMO Antenna Systems: To meet high-data-rate requirements, developing compact wideband MIMO (Multiple-Input Multiple-Output) antennas with high isolation is a key area for 5G handheld devices. Advanced Materials: Research into biodegradable and flexible substrates for wearable IoT applications.

AI-Driven Design: Optimization of complex slot geometries and DGS shapes using machine learning algorithms to achieve specific wideband characteristics.

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REFERENCES

[1]. "A Novel Design of Rectangular Microstrip Antenna for Wideband Applications" by R. Garg et al. (2018).
[2]. "Design and Analysis of Rectangular Microstrip Patch Antenna for Wireless Applications" by A. K. Singh et al. (2019).
[3]. "Wideband Rectangular Microstrip Patch Antenna Using Defected Ground Structure" by S. S. Mohan et al. (2020)
[4]. "Rectangular Microstrip Patch Antenna with Slotted Ground Plane for Wideband Applications" by P. Kumar et al. (2019)
[5]. "Microstrip Log-Periodic Dipole Antenna Analysis with Different Substrates" by Y. Li et al. (2018)
[6]. "Gain Enhancement of Rectangular Microstrip Patch Antenna Using Metamaterial" by S. K. Singh et al. (2020)
[7]. "Design of Compact Rectangular Microstrip Patch Antenna for Wireless Applications" by A. K. Verma et al. (2019)
[8]. "Wideband Rectangular Dielectric Resonator Antenna for X-Band Applications" by R. K. Chaudhary et al. (2018)
[9]. "Analysis of Rectangular Microstrip Patch Antenna with Different Feed Techniques" by P. K. Sahu et al. (2019)
[10]. "Rectangular Microstrip Patch Antenna for WLAN Applications" by S. S. K. Singh et al. (2020)