iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: V Month of publication: May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62086

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Design of Compact Size Tri-Band Stacked Patch Antenna for GPS and IRNSS

Yash Sarin[1], Snehil Sachdeva[2]
Electronics and Communication Engineering, ABES Engineering College, Ghaziabad, India

Abstract: This paper introduces a low-profile, compact tri-band microstrip patch antenna designed for GPS and IRNSS applications. The proposed antenna operates at frequencies of 1.57 GHz, 1.22 GHz, and 1.77 GHz. The antenna configuration consists of a patch antenna with a slip slot or manderline to generate three frequency bands while maintaining an acceptable radiation pattern. The focus of the study is to enhance the antenna's gain across all three frequency bands. This design aims to offer a versatile solution for navigation systems, leveraging the tri-band capability to accommodate different satellite signals and improve overall performance in GPS and IRNSS applications.
Keywords: Tri band patch antenna, GPS, IRNSS.

I. INTRODUCTION

Microstrip patch antenna is valued for compactness and versatility, with a substrate in between metallic patches and a ground plane. This paper introduces a novel approach using a single feed for the entire antenna band, employing a coaxial feed to the top patch and circular aperture couplers for the patches below. The design, a truncated square patch, operates in S-Band and L-Band frequencies, suitable for GPS and IRNSS applications. Global Navigation Satellite Systems (GNSS) are crucial in modern technology, and the paper emphasizes the significance of the Indian Regional Navigation Satellite System (IRNSS) as an independent navigation system. IRNSS comprises satellites in GEO and GSO orbits over India, providing precise positioning. The proposed dual-band circularly polarized antenna for the IRNSS receiver operates in L!, L2, L5 and S bands, receiving signals from IRNSS satellites. Simulated parameters and comparisons against design requirements use Ansoft High-Frequency Simulation Software. The paper reviews GNSS terminal antennas and details antenna design specifications and methodology for the stacked patch antenna**.**

II. ANTENNA DESIGN

A. TRI-BAND Antenna

A tri-band antenna is a type of radio frequency (RF) antenna designed to operate across three distinct frequency bands. This technology is commonly used in communication systems, wireless networks, and mobile devices to ensure optimal performance across a range of frequencies. The three bands typically refer to specific frequency ranges, such as low, mid, and high frequencies.

The advantages of tri-band antennas include increased flexibility and versatility in communication systems, allowing devices to connect and communicate over a broader spectrum of frequencies. This is particularly important in modern wireless communication, where various services and technologies operate on different frequency bands. Tri-band antennas are often employed in mobile phones and other wireless devices to support multiple wireless standards, such as GSM, 3G, 4G LTE, and 5G. By covering a wider range of frequencies, these antennas contribute to improved signal quality, faster data transfer rates, and better overall connectivity.

In summary, tri-band antennas play a crucial role in the efficiency and reliability of modern communication systems by enabling devices to operate seamlessly across three distinct frequency bands, catering to the diverse needs of wireless communication.

B. Design Configuration

The Tri-Band Stacked Patch Antenna for GPS and IRNSS features a sophisticated design configuration, accommodating the frequency bands crucial for both navigation systems. The multi-layered structure, precision-tailored to L1(1575.42 MHz), L2(1227.60 MHz), L5 (1176.45 MHz) (for GPS), and L5(1176.45 MHz), S(2492.028 MHz) (for IRNSS), integrates a well-defined feed mechanism and optimized stacking arrangement. The dielectric substrate ensures a delicate balance between compactness and radiation efficiency. Utilizing simulation tools, designers fine-tune parameters like bandwidth, gain, and radiation pattern. Prototyping and experimental validation provide real-world confirmation, ensuring adherence to navigation system specifications. The antenna design not only meets compliance with standards but also serves as a versatile solution, offering compact dimensions and high performance across multiple frequency bands for GPS and IRNSS applications.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

C. Design Methodology

The design methodology for a Tri-Band Stacked Patch Antenna, accommodating GPS and IRNSS frequency bands, involves a systematic, multifaceted approach. Commencing with the identification of critical frequency bands, encompassing L1 (1575.42 MHz) and L2 (1227.60 MHz) for GPS, and L5 (1176.45 MHz) for IRNSS, the antenna's configuration is pivotal. Opting for a stacked patch design emerges as a judicious choice, given its capacity to resonate at multiple frequencies while maintaining compactness for seamless integration into devices.

Substrate selection becomes a crucial step, dictating the dielectric properties influencing antenna size, bandwidth, and efficiency. Precision in patch geometry design is imperative to achieve resonance at specified frequencies. Electromagnetic simulation tools aid in optimizing dimensions and shapes, streamlining the tuning process. Stacking configurations are then fine-tuned to optimize distances between patches, fostering resonance across GPS and IRNSS bands.

The feed mechanism design is paramount for efficient power transfer. Microstrip feed lines or analogous techniques are tailored to the chosen antenna configuration. Tuning and optimization enter the scene, leveraging simulation tools to refine parameters like impedance, radiation pattern, and resonance, ensuring alignment with GPS and IRNSS specifications.

Subsequently, electromagnetic simulations scrutinize return loss, radiation patterns, and gain, validating the design against target frequency bands. Transitioning to the physical realm, prototyping ensues, with fabricated models undergoing experimental validation. Real-world measurements corroborate or refine simulated results, ensuring the antenna's efficacy.

Performance evaluation encompasses a comprehensive analysis of gain, radiation efficiency, and bandwidth under diverse conditions. This iterative refinement process addresses any observed shortcomings during experimental validation, fostering continuous enhancement in antenna performance.

In conclusion, this systematic methodology empowers engineers to craft a Tri-Band Stacked Patch Antenna adept at efficient operation across both GPS and IRNSS frequency bands, embodying a harmonious fusion of theoretical design, simulation, and real-world validation.

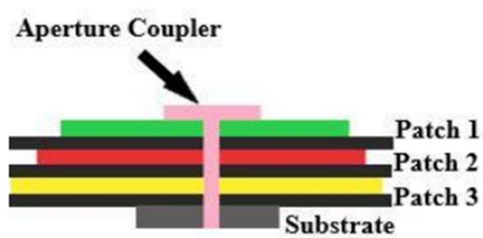
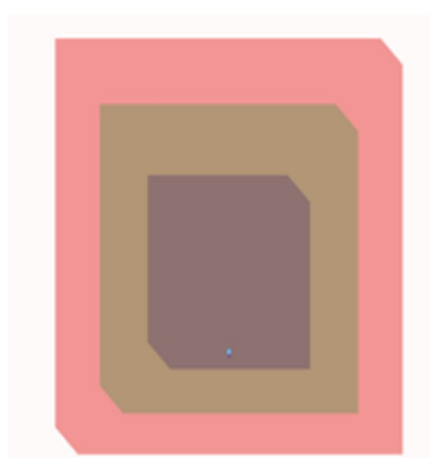


Fig. 2. Antenna's top view



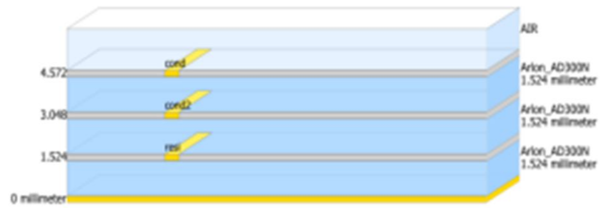


Fig. 3 Substr ate formation of the antenna design

III. CONCLUSION

This paper presents a compact Tri Band microstrip stacked patch antenna designed for operation in the 1-3 GHz frequency range. The antenna is resonating at three frequencies: L1, L2, L5 and S. With VSWR values within acceptable limits and a gain ranging from 4.5 - 5.5 dBi, the antenna is suitable for L-Band and S-Band applications like GPS and IRNSS. Additionally, a dual-band right-hand circularly polarized stacked patch antenna is proposed for IRNSS receiver applications. The antenna's characteristics, including return loss, gain, impedance bandwidth, cross-polarization separation, and axial ratio, meet the stringent design requirements for accurate and reliable data reception in IRNSS-based positioning and navigation services.

REFERENCES

[1] Shivam Singh, Dharmendra Kumar and G.S.Tripathi, “Compact Multiband Antenna with Symmetrical I- and S-shaped Slots for Wireless Applications,” in International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 2017.

[2] Kevin Geary, James H. Schaffner, Hui-Pin Hsu, Hyok J. Song, Joseph S. Colburn and Eray Yasan, “Single-Feed Dual-Band Stacked Patch Antenna for Orthogonal Circularly Polarized GPS and SDARS Applications,” in IEEE, 978-1-4244-1722-3/$25.00, 2008.

[3] Mehre-e-Munir, Ahsan Altaf,andSyed Imran Hussain Shah, “Miniaturization of Multiband Patch Antenna using Stack Configuration,” in IEEE, 978-1-4799-5754-5/14/$26.00, 2014.

[4] Mehr-e-Munir and Umar Farooq, “Multiband Microstrip Patch Antenna using DGS for L-Band, S-Band, C-Band and Mobile Applications,” in TCSET, Lviv-Slavske, Ukraine, 2016, pp. 198-201.

[5] Farhan. A. Ghaffar, Mohammad Vaseem, Langis Roy and Atif Shamim, “Design and Fabrication of a Frequency and Polarization Reconfigurable Microwave Antenna on a Printed Partially Magnetized Ferrite Substrate,” unpublished.

[6] Arumita Biswas and Vibha Rani Gupta, “A Multiband Antenna Design for Long Term Evolution (LTE) Application,” in International Conference on Signal Processing and Communication Engineering Systems (SPACES), 2015, pp. 210-214.

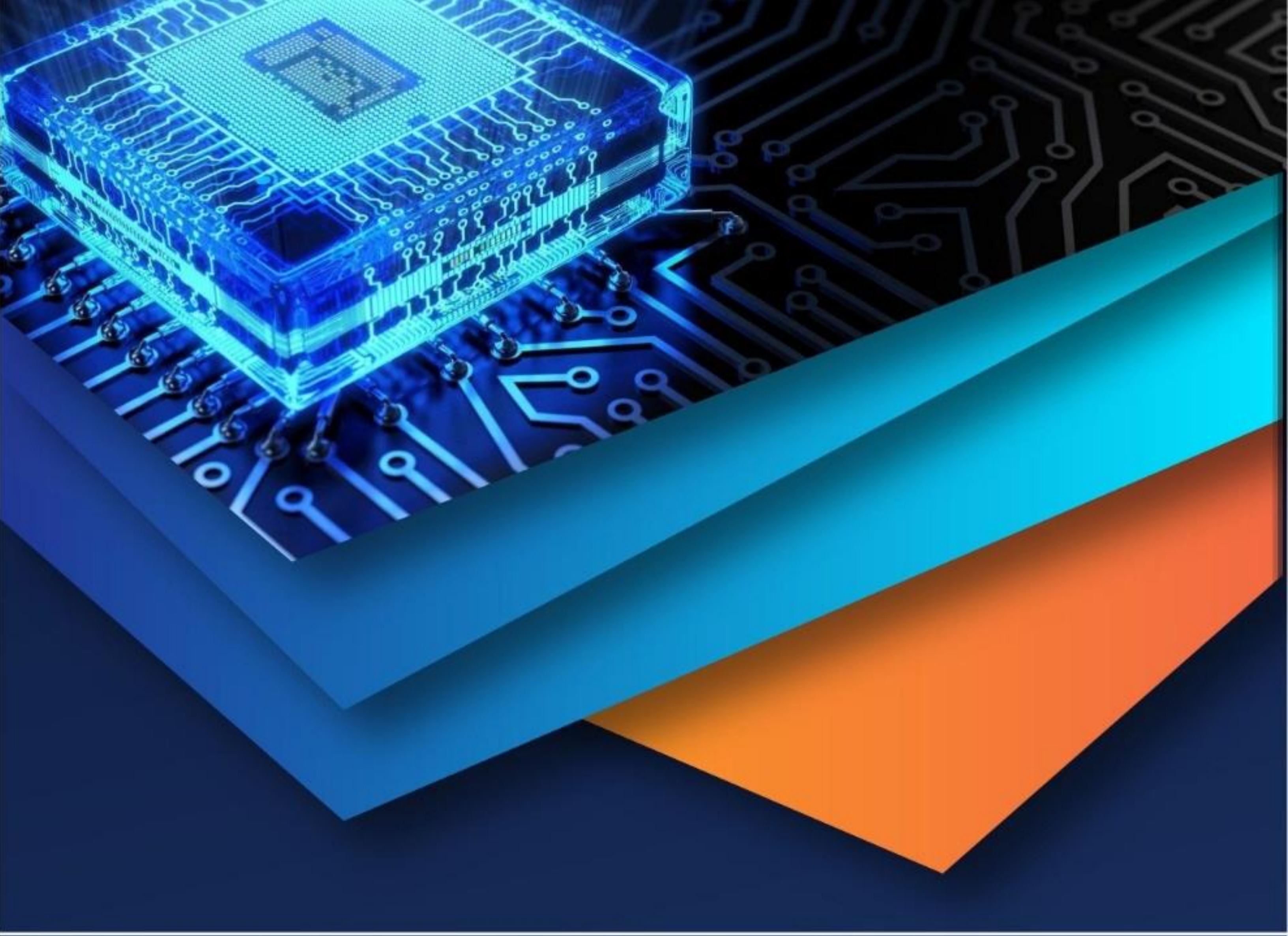
[7] Gehan Sami, Mahmoud Mohanna and Mohamed L.Rabeh, “Tri-band microstrip antenna design for wireless communication applications,” in NRIAG Journal of Astronomy and Geophysics, 2013, pp. 39-44.

[8] DhanajayKarkhur, “Review of Techniques to Design Multiband Microstrip Patch Antennas,” in International Journal of Latest Trends in Engineering and Technology (IJLTET), vol. 6, Issue. March 4, 2016, pp. 164-168.

[9] Ajay Dadhich, J. K. Deegwal, Sanjeev Yadav, and M.M.Sharma, “Design of Multi-Band Antenna With Cut Slots and Parasitic Patch for Wireless communication,”.

[10] U. Chakraborty, A. Kundu, S. K. Chowdhury and A. K. Bhattacharjee “Compact Dual-Band Microstrip Antenna for IEEE 802.11a WLAN Application,” Int. J. Adv. Res. Elect., Electron. Instrum. Eng., vol. 13, 2014, pp. 3273–3280.

[11] W. Lin and H. Wong, "Wideband Circular Polarization Reconfigurable Antenna," in IEEE Trans. Ant. Prop., vol. 63, no. 12, 2015, pp. 5938-44



doi crossref

10.22214/IJRASET

INDEX COPERNICUS

45.98

ISRA JIF

IMPACT FACTOR: 7.129

SJIFactor — TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY