



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 3, March 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com

To Minimize Mutual Coupling by Designing A MIMO Antenna with a L-Shape and Ohm Symbol Inserted

Mr.T.Vijaya Kumar, Tanniru Lavanya¹, Vudatha Bhargavi², Md.Ashrafunnisa³, Sai Sindhusa Are⁴

Assistant Professor, Department of ECE, Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt,
Andhra Pradesh, India

UG Students, Department of ECE, Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt,
Andhra Pradesh, India

Abstract: This article introduces and evaluates a small antenna with multi-band properties. A patch has three rectangular holes on the left and right sides, an inverted L-shaped slot at the top, and an embedded ohm symbol in the middle. At the frequencies of 2.2 GHz, 4.1 GHz, 5.5 GHz, 5.9 GHz, and 9.1 GHz, this design achieved multi-band characteristics. The practical applications of the ITS band, UWB, WiMAX, and WLAN band transmissions are at frequencies of 2.21–2.25 GHz, 4.08–4.13 GHz, 5.47–5.60 GHz, 5.94–6.04 GHz, and 8.93–9.25 GHz, respectively. The suggested structure is constructed and tested, and its dimensions are 1.16 k0 0.54 k0 (85*40 mm²). In a MIMO system, the mutual coupling between the two antenna elements is correlated with the direction of the current flowing across the antennas. The performance of MIMO systems suffers as a result of the mutual coupling increasing, which can have a significant impact on the antenna properties. The mutual coupling in the digital domain can be calibrated to boost performance to some extent. Many strategies, such as defective ground structures and decoupling networks, can be physically implemented to overcome mutual coupling. The L-shape inverter with the ohm sign introduced is analysed and briefly explored from both a theoretical and principle perspective. Furthermore noted is the independent operation of the L-shape structure and the ohm symbol inserted on the patch resonators, as well as the ability to tune the impedance bandwidths separately to reduce mutual coupling by modifying the dimensions and placements.

Keywords: MIMO Antennas; Mutual Coupling; Ohm symbol; L-shape stub

I. INTRODUCTION

In the recent years new opportunities for the mobile sector have emerged as a result of the tremendous advancement in a wireless communications technology. A wide range of wireless applications, including online gaming and small live HDTV broadcasting equipment, use MIMO communication technology because it can handle more data volume than conventional antenna designs. The compact structure, excellent mutual coupling, low ECC, and great radiation efficiency of this MIMO technology all contribute to its effectiveness. WiMAX utilises a frequency of 3.5 GHz because it produces a strong FBR (front to back radiation). The MIMO structure design has an omnidirectional and a bidirectional radiation pattern in the E-field and H-field, respectively. There are wireless applications now that use these consistent radiation patterns. This demonstrates the ability of the MIMO-designed structure to make use of contemporary wireless communication applications. It can be used into real-world applications because of its simple form. The design system's complexity and expense are decreased. This design featured a combination of an inverted L-shape and an inverted ohm shape that significantly reduced the mutual coupling parameter (S_{12}) and resulted in multi-band operations. This design was created using step-by-step analysis to create rectangular slots on both sides of the patches, greatly reducing the mutual coupling parameter. It was also observed by the optimization procedure, which kept the spacing between the elements at 0.0683 k0, and its mutual coupling was found to be around 71.2 dB. The suggested MIMO antenna satisfies three key requirements for MIMO antennas in today's wireless communication systems: multi-band operations, steady radiation patterns, improvement in bandwidth, strong gain, low losses, and compactness.

II. DESIGN METHODOLOGY

The design is built on a 1.6 mm thick, commonly available, and inexpensive FR-4 substrate. The substrate is considered to have a dielectric constant of 4.4. The suggested antenna is simulated and optimized using the CST (Computer Simulation Technology) Design Suite Version 2019. There are seven stages of MIMO antenna to depict the seven evaluation stages. The basic design of square patch can resonate at frequencies 4.1, 6.2, 6.9, 8.3, 9.4 GHz. In our design we have subtracted rectangular slit and square slit at both the sides of the patch. When the rectangular and square slits are subtracted the patch is resonated at different frequency bands such as 6.6 and 8.7 GHz. Thus the same procedure is applied by subtracting the rectangular and square slits from both sides of the patch and hence at different stages the patch is resonated with particular frequencies. In the next evaluation stage an inverted L-shape is subtracted from the top of the patch and at this stage the patch is resonated at tri-band frequencies. Reflection coefficient is an important factor of antennas so as to improve this we have inserted inverted ohm symbol on the patch and the patch is resonated at frequencies used in UWB applications. After all the seven evaluation stages required MIMO antenna design is done and this antenna is resonating at multi-band frequencies and various system performance parameters are measured, such as VSWR, Reference Impedance, Radiation Patterns, S-parameters $|S_{11}| < -10\text{dB}$ and $|S_{22}| < -20\text{dB}$.

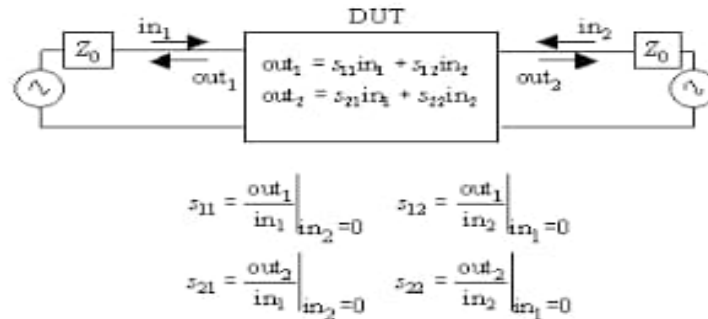
III. RELATED WORK

A very straightforward and small complementary slot reflector element with a size of $14 \times 9.5 \text{ mm}^2$ is introduced in place of any complicated back-lobe reduction approach, multiple reflectors, or additional reflector layers as reported in the literature to obtain a minimum measured FBR of 10 d. Without adding any additional metallic director layers, this MIMO antenna system offers a minimum measured realised gain of 4.3 dBi and a minimum measured isolation of 12 dB across the operating band [1]. A MIMO antenna with a very compact size of $22 \times 36 \text{ mm}^2$ has been designed for portable UWB applications. Two square monopole elements are used to provide UWB operation from 3.1-10.6 GHz. A T-shaped ground stub with a slot is used between the monopole elements to reduce mutual coupling to below -15 dB. Two ground strips are used to create a deep band notch from 5.15-5.85 GHz to suppress interference in the WLAN band [2]. The mutual coupling between the array elements is demonstrably reduced by adding a linear slot between nearby waveguide slot antennas, in the case described by 20 dB to 32 dB across Ku- and K- bands. The gain performance has also been markedly enhanced [3]. A brand-new dual band-notched ultrawideband slot MIMO antenna system is suggested and examined. For 5G WLAN and 8 GHz X band, respectively, the suggested antenna system offers anti-interference capability. In such a small space, high isolation (S_{21} 15 dB) between closely spaced antenna elements is achieved [4]. This research presents a novel meta surface superstrate-based antenna decoupling technique. With only a 0.27-wavelength separation between the two bowtie antennas, this technique can disconnect them while maintaining a 25dB isolation and a 16% fractional bandwidth. The approach may eventually be extended to dual-polarized arrays, rectangular arrays with both E and H coupling, and linear arrays with more components [5]. For wideband applications, a compact embedded periphery array of slot antennas measuring $25 \times 20 \times 1.6 \text{ mm}^3$ is seen to resonate at four bands with a $|S_{12}| > -26\text{dB}$ [6]. Edge-to-edge spacing between the antennas may be lowered to 0.65 using the suggested method, and the best measured isolation enhancements in the X, Ku, K, and Ka bands are 37 dB, 21 dB, 20 dB, and 31 dB [7]. A novel triband E-shaped printed monopole antenna loaded with narrow slots has been presented. The MIMO antenna array provides better than -14dB mutual coupling, envelope correlation of lower than 0.002 and stable omnidirectional patterns.

In this study, we employ a decoupling technique to lower mutual coupling by inserting an inverted L-shape and an ohm symbol at a distance of 2 mm between the patches, which results in a mutual coupling of larger than -20 dB [8].

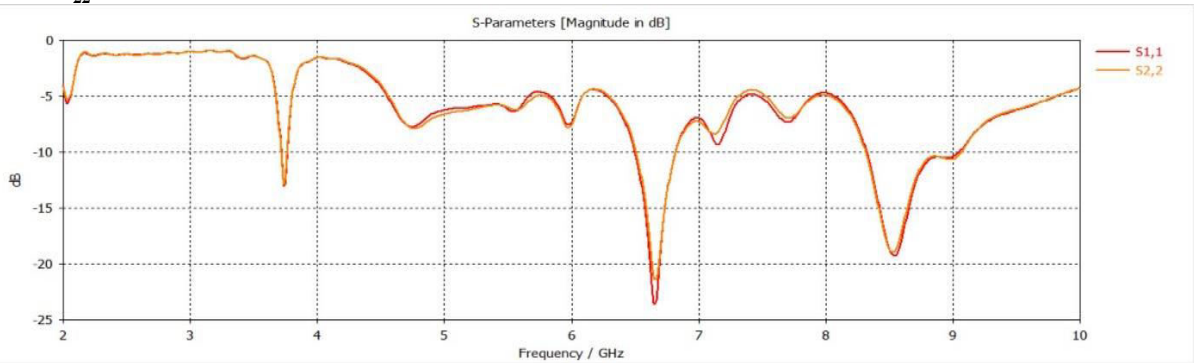
IV. S-PARAMETERS

We are unable to employ other analysis parameters, such Z, Y, and H parameters, because short circuit and open circuit analysis are not possible in RF design. S-parameters are used to characterise the input-output relationship between ports (or terminals) in an electrical system. At high frequencies, it becomes essential to define a network in terms of waves rather than voltage or current. Power waves are therefore utilised in S-parameters. The relationships between ports in an electrical system's scattering parameters describe the input-output interactions. A network must be described in terms of waves rather than voltage or current, especially at high frequency. Thus, power waves are used in S-parameters.

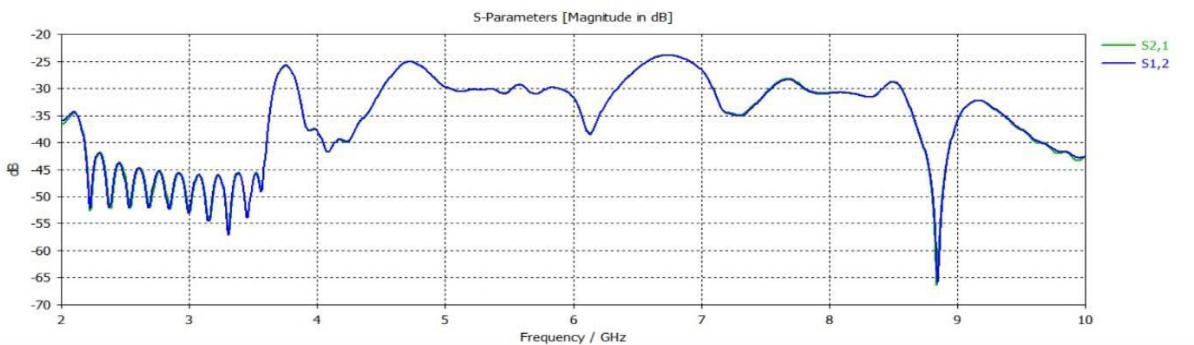


S_{11} is the input port voltage reflection coefficient.
 S_{12} is the reverse voltage gain.
 S_{21} is the forward voltage gain.
 S_{22} is the output port voltage reflection coefficient.

S_{11} AND S_{22} :



S_{12} AND S_{21} :

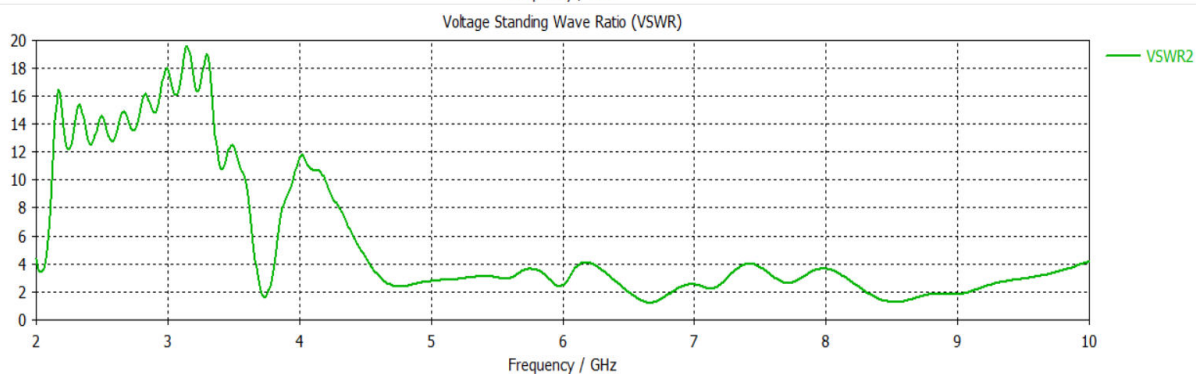
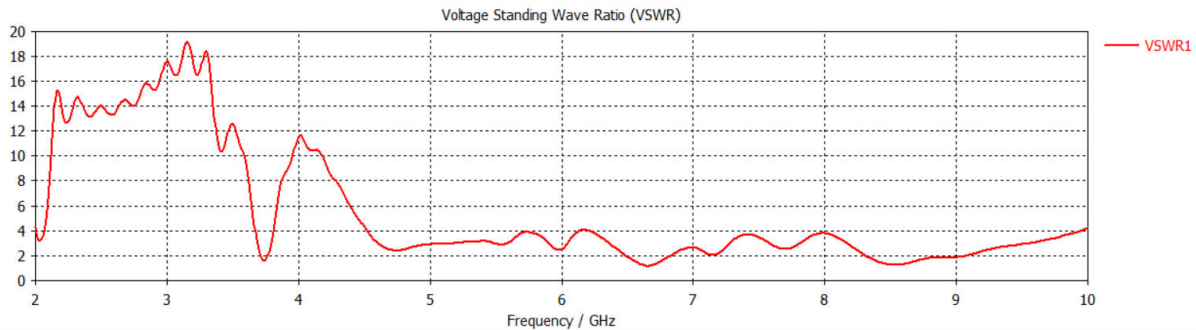


V. VSWR

Voltage Standing Wave Ratio, or VSWR for short, is also known as Standing Wave Ratio (SWR). The power reflected from the antenna is described by the reflection coefficient, which affects VSWR. The following formula determines the VSWR if the reflection coefficient is determined by S_{11} , reflection coefficient, or return loss:

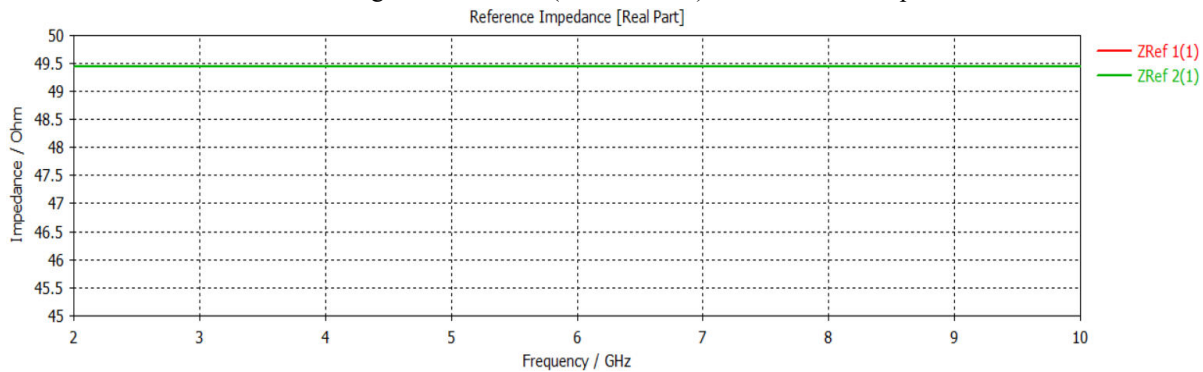
$$VSWR = \frac{1 + |S_{11}|}{1 - |S_{11}|}$$

Antennas always have a true, positive VSWR value. More power is transmitted to the antenna and the antenna is more effectively matched to the transmission line the smaller the VSWR. 1.0 is the required VSWR. The antenna's performance in this instance is optimal because no power is reflected from it.



VI. REFERENCE IMPEDANCE

S parameters are specified using a reference impedance value. The reference impedance is required if you have S-Parameters and need data on voltages and currents (or vice versa). The reference impedance obtained is 49.5Ω .



VII. FAR-FIELDS

Far-field refers to the area of the field that is distant from the antenna. Due to the significant radiation effect in this region, it is also known as a radiation field. Only in this region are several antenna characteristics, antenna directivity, and antenna radiation pattern taken into account. The field pattern is the quantification of the field distribution in terms of field intensity. That implies that the plotted radiated power from the antenna is stated in terms of the electric field, E (v/m). As a result, it is known as the field pattern. It is referred to as a power pattern if it is measured in terms of power (W). This reactive near field, also known as a non-radiative field, is located very close to the antenna yet does not have a significant radiation component. Due to the radiation's dominance and the angular field distribution, the area nearby might be referred to as a Fresnel field or radiating near field. It radiates far-field region, which is the area next to it. The distribution of the field is unaffected by antenna distance in this area.

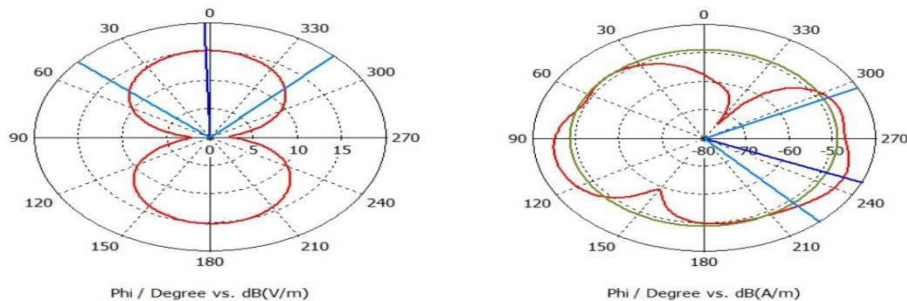


Fig: E-field and H-field at 6GHz

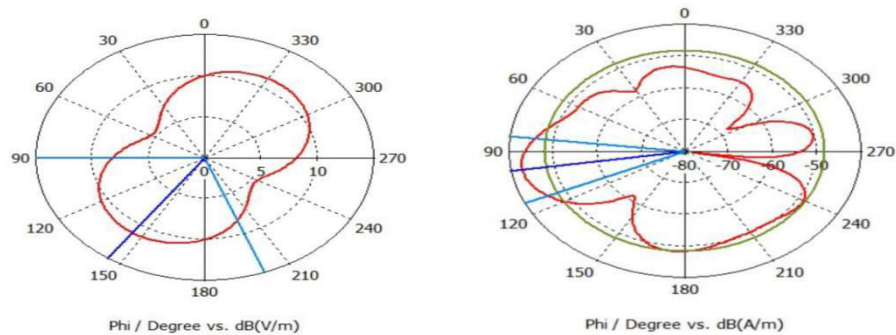


Fig: E-field and H-field at 10GHz

VIII. CONCLUSION

The design of the MIMO antenna incorporates the Ohm symbol and an inverted L-shape into both patches. FR-4 lossy substrate was used to manufacture and experimentally test a MIMO antenna system with dimensions of 80 x 40 mm². In order to get the intended outcomes, the patches' dimensions and separation distances were taken into account. Software called CST was used to simulate the suggested design. At frequencies of 6.7GHz and 8.8GHz, we also reduced the mutual coupling by -66dB for the intended MIMO antenna, which had a return loss of -10dB and a VSWR of 1.8, and the designed single port antenna, which had a return loss of -24dB and a VSWR of 1.8.

REFERENCES

- [1] Syed Jehangir S, Sharawi MS. A single layer semi-ring slot yagi-like MIMO antenna system with high front-to-back ratio. *IEEE Trans Antennas Propag* 2017;65(2):937–42.
- [2] Cheung SW, Liu Li, Yuk TI. Compact MIMO antenna for portable UWB applications with band-notched characteristic. *IEEE Trans Antennas Propag* 2015;63(5):1917–24.
- [3] Alibakhshikenari Mohammad et al. A new waveguide slot array antenna with high isolation and high antenna bandwidth operation on Ku-and K-bands for radar and MIMO systems. 2018 15th European Radar Conference (EuRAD). IEEE; 2018.
- [4] Jianfeng Zhu et al. A dual notched band MIMO slot antenna system with Yshaped defected ground structure for UWB applications. *Microwave Opt Technol Lett* 2016;58(3):626–30.
- [5] Liu Feng et al. A meta-surface decoupling method for two linear polarized antenna array in sub-6 GHz base station applications. *IEEE Access* 2019;7:2759–68.
- [6] Alibakhshikenari Mohammad et al. Antenna mutualcoupling suppression over wideband using embedded periphery slot for antenna arrays. *Electronics* 2018;7(9):198.
- [7] Alibakhshikenari Mohammad et al. Mutual coupling suppression between two closely placed microstrip patches using EM-bandgap metamaterial fractal loading. *IEEE Access* 2019.
- [8] Zhang Z, Wang H, Liu L, Li Y, Feng Z. A wideband compact WLAN/WiMAX MIMO antenna based on dipole with V-shaped ground branch. *IEEE Trans Antennas Propag* 2015;63(5):2290–5.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details