International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING

ISSN:2147-6799 www.ijisae.org Original Research Paper

Design and Development of L Shaped Antenna for Wireless Communication

Jacob Abraham*[1], Kannadhasan Suriyan[2]

Submitted: 10/09/2022 **Accepted:** 20/12/2022

Abstract: The performance of a coaxially fed L-shaped microstrip patch antenna for WLAN applications is presented in this research. An L-shaped structure was etched on a rectangular patch to create the desired antenna. The suggested antenna is built on a thick substrate FR4 to obtain the needed bandwidth. The frequencies are used to operate at 2.6GHz, 3.4GHz, 4.8GHz and 6.1GHz. The return loss is obtained at various frequencies for 2.6GHz at -27.98dB, 3.4GHz at -15.18dB, 4.8GHz at -25.63 and 6.1GHz at -11.61dB. The VSWR is obtained at various frequencies for 2.6GHz at 1.2, 3.4GHz at 1.4, 4.8GHz at 1.3 and 6.1GHz at 1.8. The Gain is obtained at various frequencies for 2.6GHz at 3.1dB, 3.4GHz at 3.18dB, 4.8GHz at 3.12dB and 6.1GHz at 3.48dB. The obtained properties indicate that the suggested antenna might be used in a contemporary communication system with size and weight limitations.

Keywords: *L Shaped, VSWR, Gain, Return Loss and Radiation Pattern*

1. Introduction

Microstrip patch antenna research has advanced significantly in recent years. Microstrip patch antennas offer greater benefits and higher prospects than traditional antennas. A probe-fed antenna with a microstrip patch design is proposed for use in a Wireless Local Area Network (WLAN). With the rise of wireless systems and the growing need for new wireless applications like WLAN (Wireless Local Area Network), it's more necessary than ever to develop broadband and high gain antennas that can span a wide frequency range. For contemporary wireless applications, designing an efficient broad band compact size antenna is a big difficulty. Small size, low-cost manufacture, low profile, conformability and simplicity of installation, as well as integration with feed networks, are the primary restrictions in applications such as high-performance aircraft, satellites, missiles, mobile radio, and wireless communications. In addition, as technology advances, the need for an antenna that can resonate at many frequencies (multi-banding) is becoming increasingly prevalent [1]-[5].

The best option for meeting all of the aforementioned criteria is a microstrip patch antenna. A microstrip patch antenna also has a number of benefits over traditional antennas, such as reduced manufacturing costs, the ability to handle both linear and circular polarisation, and so on. Surface wave excitation, restricted bandwidth, and other drawbacks of microstrip patch antennas exist. However, eliminating U-slots, raising substrate height, lowering substrate r, and other ways may enhance the bandwidth of a microstrip patch antenna. A multi-antenna array may also help to increase bandwidth. To begin, we'll create a basic microstrip patch antenna with coaxial feed. The inner conductor of the coaxial connection travels from ground through the substrate and is connected to the radiating patch in this feeding approach, while the outer conductor extends from ground up to substrate. the patch to correctly match with its input impedance [6]-[10]. This feed mechanism is simple to make and emits little spurious radiation. Its main disadvantage is that it has a limited bandwidth and is difficult to model since a hole must be bored in the substrate and the connection protrudes beyond the ground plane, making it non-planar for thick substrates. However, the bandwidth may be increased using the techniques listed above. Many microstrip patch antennas with coaxial-feed have recently been proposed for various purposes.

However, in comparison to the area typically available in a mobile wireless device, these antennas are rather enormous. In order to shrink the size of an antenna, researchers have been working on slot designs. To achieve dual and multiband operations, the author employed U-slots with an L-probe feed. An antenna capable of operating at a single frequency band has been suggested in this research. To enable singleband functioning, the suggested design incorporates an L-shape within a rectangular patch. Today's cutting-edge antenna technology allows for the employment of a variety of antenna kinds and models, depending on the application [11]-[15]. Small size, low profile, and wideband multifrequency planar antennas are desired with the fast growth of wireless communications. Because of its compactness, cost-effectiveness, light weight, low profile, and conformability to any structure, microstrip antennas are currently widely utilised in numerous communication systems. The biggest disadvantage of using these antennas in many applications is the narrow bandwidth they provide. However, increasing the bandwidth and gain of microstrip antennas is the most difficult problem [16]-[20]. Several strategies for achieving multi-band performance have recently been presented including multilayer

[1]*Department of Electronics, B P C College, Piravom, Eranakulam, Kerala, India*
[2] *Department of Electronics and Communication Engineering, Study World College of Engineering, Coimbatore, Tamil Nadu, India*
ORCID ID : 0000-0001-6443-9993
** Corresponding Author Email: tjacobabra@gmail.com*

stacked patch, multi resonator, and the insertion of slots and slits of varied shapes and sizes in patch antennas [21]-[25].

2. Proposed Structure of L-Shaped Antenna

Tunable or dual frequency antenna features are achieved when a microstrip patch antenna is loaded with reactive components such as slots, stubs, or a shorting pin. Introducing the slots on a single patch is the most common method for producing dual-frequency behaviour. The slots do not increase the patch size or have a significant effect on the patch's radiation pattern since they are cut at a suitable location within the patch. These slots may be rectangular or square, step, tooth-brush shaped, V-slot, Uslot, and other forms. The slot creates a dual frequency response by adding another resonant mode near the patch's fundamental mode. Due to the allocation of the frequency band for unlicensed use by several international regulators, wideband antenna research has received a lot of interest and has expanded in the previous decade. The literature has produced a number of different wideband antennas. The most often used antenna components are the double-ridged waveguide horn antenna, tapered slot antenna, log periodic antenna, helix antenna, and self-complementary antenna all of which span multiple wavelengths.

Some tiny planar antennas have lately been suggested and explored in order to minimise the size of wideband antennas. Microstrip-fed patch antennas, microstrip-fed slotted antennas, CPW-fed patch antennas, and CPW-fed slot antennas of different forms are common designs. Both frequency and temporal domain data have been thoroughly studied. However, although the radiation patterns are not steady over the operational frequency range, the above-mentioned antennas may accomplish wideband impedance matching. Bowtie patches and an electric dipole make up the magneto-electric antenna. An open-ended slot antenna is made up of two shorted-circuited patches set in a mirror to each other. In addition, the excited electric dipole radiation is augmented using a pair of parasitic L-wires. Across the working bandwidth, the proposed antenna has comparable E and H radiation patterns. Figure 1 shows the proposed low-profile patch antenna's geometry, which is driven by an L-shaped feeding arrangement. Table 1 shows the design parameters of L-shaped antenna structure.

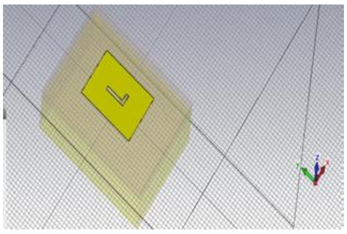

Figure.1. L-Shaped Structure

Table.1. Design Parameters of L-Shaped Antenna

Sl.No	Parameters	Range
1	Substrate	FR4
2	Thickness of Substrate	1.8 mm
3	Input Impedance	50 ohm
4	Operating Frequencies	2.6GHz, 3.4GHz, 4.8GHz and 6.1 GHz
5	Length (L)	78.96mm
6	Width (W)	34.77mm
7	Antenna Size	25mmX20mmX10mm

3. Results and Discussion

The suggested antenna's S11 parameter was computed, and the simulated return loss results are shown in Figure 2. When the load is mismatched and not all of the available power from the generator is transferred to the load, return loss is a useful technique to describe the input and output of the signal sources. The return loss is the name given to this loss (RL). In this suggested antenna, the return loss is -27.98 dB. For 6.1 GHz WLAN applications, the obtained return loss value is modest enough, and the frequency is near enough to the required frequency range. The return loss value of -27.98dB indicates that there is strong matching at the frequency point, which is below the -10 dB zone. A negative value of return loss indicates that this antenna experienced few losses when sending signals.

The suggested quad band microstrip patch antenna was tested in the HFSS Simulator and optimised. The size of the L-shape (length and Width of the L-slot), the gap between the L-shape patch, and the diameter of the rectangular slot on the ground plane are the major design parameters employed in the optimization. The next paragraphs in this section go through a full study of these factors. This is accomplished by altering the upper and lower ground planes. The ground plane, which is shaped like a rectangle and covers the full back of the substrate, is positioned on the reverse side of the substrate. A measure of impedance mismatch is the VSWR (Voltage Standing Wave Ratio). As shown in Figure 3, the suggested antenna's VSWR ratio is 1.4, which should be between 1 and 2.

In this research, we looked at a Micro strip Patch Antenna for WLAN applications having an L-shaped etched structure. The suggested antenna is created by etching an L-shaped basic structure on a rectangular patch on a FR-4 substrate. It has a return loss of -27.98dB at 2.6 GHz, resulting in a bandwidth of roughly 313 MHz at that frequency (4.99-5.31GHz). The suggested antenna has a VSWR of 1.2, a gain of 3.48 dB, and a directivity of 3.12dB at 4.8GHz.

The printed antenna is made up of three layers of substrates, with a pair of radiating patches on top, a pair of grounded patches in the centre, and a feeding patch on the bottom. The simulated outcome of VSWR is shown in Figure 3. The determined operational frequency band (VSWR 2) spans the range of 2 to 6.1GHz, with a relative bandwidth of roughly 70%. Furthermore, in both major planes, the suggested patch antenna may attain minimal crosspolarization levels. At 4 GHz, Figure 5 depicts typical radiation patterns. Cross-polarization is less than -30dB when compared to copolarization. It's also worth noting that the front-to-back ratio is well above 15 decibels. Figure 4 also shows the simulated outcome of achieved gain. The realised gain rises in value as the operating frequency rises. By extending the ground plane, the lower frequency band's lower antenna gain may be enhanced. The length and Width of the L-material body opening have been improved as well as the location of the gaps along the x and y-pivot for a long duration of round polarisation radioactive design. Well-ordered L-shape gaps cut on the highest point of the fix to achieve the desired radio wire

The planned antenna with the four L-shape slots in a simulated restored red public presentation. The crucial intent parameters are determined by the arm length and breadth of the L-shaped slot, as well as the interruption between successive L-slots and the temporary connection size of the antenna.

HFSS software is used to propose and simulate LMA with anti-symmetric horizontal L-slots on the ground plane. The results of the proposed antenna in terms of S11, VSWR, gain, and radiation pattern as a function of frequency will be discussed in this section. Figure 2 shows a simulation of the current antenna's return loss. The return loss is obtained at various frequencies for 2.6GHz at -27.98dB, 3.4GHz at -15.18dB, 4.8GHz at -25.63 and 6.1GHz at -11.61dB. The VSWR is obtained at various frequencies for 2.6GHz at 1.2, 3.4GHz at 1.4, 4.8GHz at 1.3 and 6.1GHz at 1.8. The Gain is obtained at various frequencies for 2.6GHz at 3.1dB, 3.4GHz at 3.18dB, 4.8GHz at 3.12dB and 6.1GHz at 3.48dB.

The antenna is constructed at a certain resonant frequency, resulting in a certain bandwidth; however, the insertion of a slot overlaps the fundamental mode of the antenna, generating a higher order mode that overlaps the original bandwidth, progressively increasing the antenna's total bandwidth.

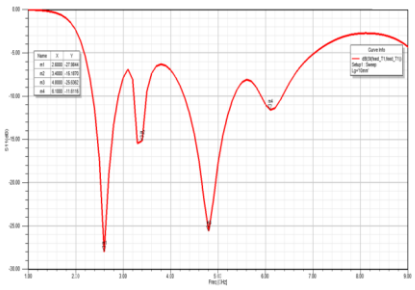

Figure.2. Return Loss of the Antenna

The VSWR of the provided antenna is shown on Fig.3. The VSWR is 2 for all resonant frequencies, indicating that the planned antenna has adequate impedance matching.

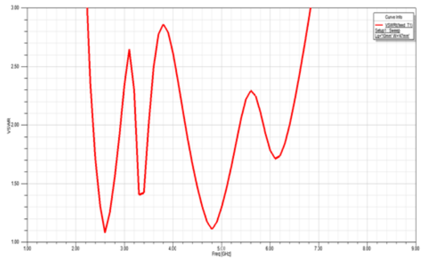

Figure.3. VSWR of the Antenna

Figure 4 shows the simulated gain of the planned antenna. The gain gained in the operational band is 2.6GHz at 3.1dB, 3.4GHz at 3.18dB, 4.8GHz at 3.12dB and 6.1GHz at 3.48dB . The electrical length of ground increases as a result of the slot insertion. Gain is increased because to the high coupling between ground and patch. The provided antenna achieves positive gain at all resonant frequencies, indicating that the antenna is performing well.

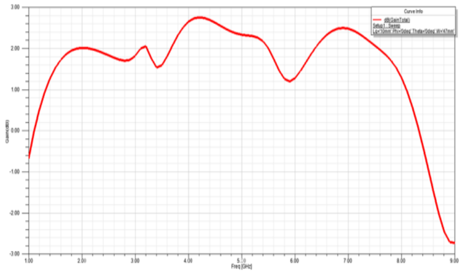

Figure.4. Gain of the Antenna

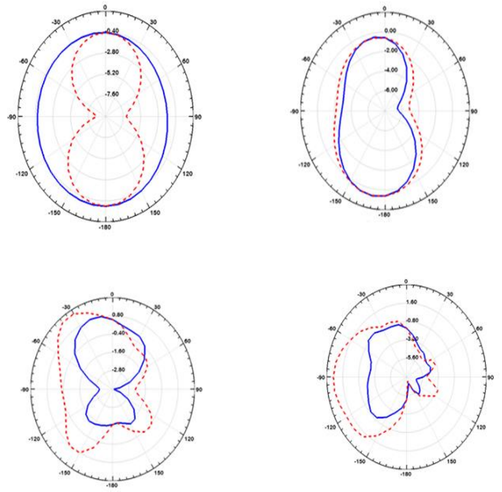

Figure.5.Radiation Pattern of the Antenna

4. CONCLUSION

This work presents the design and investigation of a unique printed low-profile patch antenna with a broad bandwidth. The L-shaped feeding mechanism is used to provide wideband performance. The return loss is obtained at various frequencies for 2.6GHz at -27.98dB, 3.4GHz at -15.18dB, 4.8GHz at -25.63 and 6.1GHz at -11.61dB. The VSWR is obtained at various frequencies for 2.6GHz at 1.2, 3.4GHz at 1.4, 4.8GHz at 1.3 and 6.1GHz at 1.8. The Gain is obtained at various frequencies for 2.6GHz at 3.1dB, 3.4GHz at 3.18dB, 4.8GHz at 3.12dB and 6.1GHz at 3.48dB.The suggested antenna may function across a broad frequency spectrum from 2.6 to 6.1GHz with low-cross polarisation and a high front-to-back ratio, according to simulation findings.

Author contributions

Jacob Abraham: Design, Conceptualization, Methodology, Software, Field study and Writing

Kannadhasan Suriyan: Analysis, Writing-Original draft preparation, Software, Validation., Field study and Discussion

Conflicts of interest

The authors declare no conflicts of interest.

References

[1]. Alemaryeen, A., & Noghanian, S. (2019). On-body low profile textile antenna with artificial magnetic conductor. *IEEE Transactions on Antennas and Propagation*, 67(6), 3649–3656. https://doi.org/10.1109/TAP.2019.2902632

[2]. Al-Sehemi, A., Al-Ghamdi, A., Dishovsky, N., Atanasov, N., & Atanasova, G. (2018). Design and performance analysis of dual-band wearable compact lowprofile antenna for body-centric wireless communication. International Journal of Microwave and Wireless Technologies, 10(10), 1–11. https://doi.org/10.1017/S1759078718001058

[3]. Bhattacharjee, S., Maity, S., Chaudhuri, S. R. B., & Mitra, M. (2019). A compact dual-band dual-polarized omnidirectional antenna for on-body applications. IEEE Transactions on Antennas and Propagation, 67(8), 5044–5053. https://doi.org/10.1109/TAP.2019.2891633

[4]. Yadav, P. ., S. . Kumar, and D. K. J. . Saini. "A Novel Method of Butterfly Optimization Algorithm for Load Balancing in Cloud Computing". International Journal on Recent and

Innovation Trends in Computing and Communication, vol. 10, no. 8, Aug. 2022, pp. 110-5, doi:10.17762/ijritcc.v10i8.5683.

[5]. Chen, Z. Y., Gao, Y. M., & Du, M. (2018). Propagation characteristics of electromagnetic wave on multiple tissue interfaces in wireless deep implant communication. IET microwaves. Antennas & Propagation, 12(13), 2034–2040. https://doi.org/10.1049/iet-map.2018.5315

[6]. Chi-Lin, T., Chen, K. W., & Yang, C. L. (2015). Implantable wideband low-SAR antenna with C-shaped coupled ground. IEEE Antennas and Wireless Propagation Letters, 14, 1594–1597. https://doi.org/10.1109/LAWP.2015.2413839

[7]. R. Munson, "Conformal microstrip antennas and microstrip phased arrays," IEEE Transactions on Antennas and Propagation, vol. 22, no. 1, pp. 74–78, 1974.

[8]. J. Howell, "Microstrip antennas," IEEE Transactions on Antennas and Propagation, vol. 23, no. 1, pp. 90–93, 1975.

[9]. N. X. Anusha, S. Vimal, and V. Jackins, "DSA-based secured communication in 5G vehicular networks using edge computing," Computational Intelligence in Pattern Recognition, Springer, Berlin, Germany, pp. 389–400, 2022.

[10]. S. Saralch, V. Jagota, D. Pathak, and V. Singh, "Response surface methodology based analysis of the impact of nanoclay addition on the wear resistance of polypropylene," The European Physical Journal - Applied Physics, EDP Sciences, vol. 86, no. 1, Article ID 10401, 2019.

[11]. Ahmed Cherif Megri, Sameer Hamoush, Ismail Zayd Megri, Yao Yu. (2021). Advanced Manufacturing Online STEM Education Pipeline for Early-College and High School Students. Journal of Online Engineering Education, 12(2), 01–06. Retrieved from http://onlineengineeringeducation.com/index.php/joee/article/view/47

[12]. Q. Yao, M. Shabaz, T. K. Lohani, M. Wasim Bhatt, G. S. Panesar, and R. K. Singh, "3D modelling and visualization for vision-based vibration signal processing and measurement," Journal of Intelligent Systems, vol. 30, no. 1, pp. 541–553, 2021

[13]. Anguera, J., Puente, C., Borja, C., & Soler, J. (2005). Fractal shaped antennas: A review. Encyclopedia of RF and Microwave Engineering. https://doi.org/10.1002/0471654507.eme128.

[14]. Bakariya, P. S., Dwari, S., Sarkar, M., & Mandal, M. K. (2015). Proximity-coupled microstrip antenna for bluetooth, WiMAX, and WLAN applications. IEEE Antennas and Wireless Propagation Letters,14, 755–758.

[15]. Mehdipour, A., Sebak, A. R., Trueman, C. W., & Denidni, T. A. (2012). Compact multiband planar antenna for 2.4/3.5/5.2/5.8-GHz wireless applications. IEEE Antennas and Wireless Propagation Letters.,11, 144–147.

[16]. Salamin, M. A., Das, S., & Zugari, A. (2018). Design and realization of low profile dual-wideband monopole antenna incorporating a novel ohm (Ω) shaped DMS and semi-circular DGS for wireless applications. AEU-International Journal of Electronics and Communications,97, 45–53.

[17]. Yong J (2012) "Compact Dual-Band CPW-Fed Zeroth-Order Resonant Monopole Antennas "IEEE Antennas and Wireless Propagation letters, vol. 11

[18]. Hassan Tariq C, Muhammad N, Abbasi QH, Yi H, AlJa'afreh SS (2013) "Compact Low-Profile Dual-Port Single Wideband Planar Inverted-F MIMO Antenna", IEEE Antennas and Wireless Propagation Letters, VOL. 12

[19]. Qinjiang R, Kelce W (2011) Design, Modeling, And Evaluation Of A Multiband MIMO/Diversity Antenna System For Small Wireless Mobile Terminals'. IEEE Trans Components Packaging Manuf Technol 01:03

[20]. Hong, Y.; Tak, J.; Choi, J. Dual-band dual-mode patch antenna for on–on–off WBAN applications. Electron. Lett. 2014, 50, 1895–1896.

[21]. Tak, J.; Woo, S.; Kwon, J.; Choi, J. Dual-band dual-mode patch antenna for on-/off-body WBAN communications. IEEE Antennas Wirel. Propag. Lett. 2016, 15, 348–351.

[22]. Khajeh-Khalili, F.; Shahriari, A.; Haghshenas, F. A simple method to simultaneously increase the gain and bandwidth of wearable antennas for application in medical/communications systems. Int. J. Microw. Wirel. Technol. 2021, 13, 374–380.

[23]. Zhou, L.T.; Fang, S.J.; Jia, X. A Compact Dual-Band and Dual-Polarized Antenna Integrated into Textile for WBAN Dual-Mode Applications. Prog. Electromagn. Res. Lett. 2020, 91, 153–161.

[24]. Mashaghba, H.A.; Rahim, H.A.; Soh, P.J.; Abdulmalek, M.; Adam, I.; Jusoh, M.; Sabapathy, T.; Yasin, M.N.; Rani, K.N.A. Bending Assessment of Dual-Band Split Ring-Shaped and Bar Slotted All-Textile Antenna for Off-Body WBAN/WLAN and 5G Applications. In Proceedings of the 2020 2nd International Conference on Broadband Communications, Wireless Sensors and Powering (BCWSP), Yogyakarta, Indonesia, 28–30 September 2020; pp. 1–5.

[25]. Ravita, R., & Rathi, S. (2022). Inductive Learning Approach in Job Recommendation. International Journal of Intelligent Systems and Applications in Engineering, 10(2), 242–251. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/1829

[26]. Gabriel, S.; Lau, R.W.; Gabriel, C. The dielectric properties of biological tissues: II. Measurements in the frequency range 10 Hz to 20 GHz. Phys. Med. Biol. 1996, 41, 2251.

[27]. Deng, JY, Li, JY, Zhao, L and Guo, L (2017) A dual-band inverted-F MIMO antenna with enhanced isolation for WLAN applications. IEEE Antennas and Wireless Propagation Letters 16, 2270–2273.

[28]. Khan, A, Jamaluddin, M, Aqeel, S, Nasir, J, Kazim, J and Owais, O (2017) Dual-band MIMO dielectric resonator antenna for WiMAX/WLAN applications. IET Microwaves, Antennas & Propagation 11, 113–120

[29]. Gupta, D. J. . (2022). A Study on Various Cloud Computing Technologies, Implementation Process, Categories and Application Use in Organisation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 09–12. https://doi.org/10.17762/ijfrcsce.v8i1.2064