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A Novel Compact Multiband Antenna Design for Wireless Applications

Muneer Ahmed S*, Kamran M, Aziz ul haq M

Department of Electronic Engineering, Capital University of Science and Technology, Islamabad, Pakistan

Abstract: Microstrip patch antennas are becoming essential component in many emerging wireless communication applications. The high demand of these antennas in such devices is due to a number of attractive properties of these antennas. This paper present a novel design of microstrip patch antenna, which can be used in mobile devices for microwave, wireless communication and e-Health applications. The proposed design of the antenna is based on multi rectangular structured slots on the patch in order to operate at multiple frequency bands. The slots are designed on the rectangular patch and fed by a microstrip feeder line. The proposed design and quarter wave transformer feeding technique allows the antenna to operate at multiple frequencies in the range of 2-9 GHz which includes most of the wireless applications. It is shown that six different operational frequency bands have voltage standing wave ratio (VSWR) ≤ 2, which is an acceptable range for short to medium range wireless communication. The operating bands of frequency are: 2.8 GHz, 2.9 GHz, 4.0 GHz, 4.5 GHz, 7.6 GHz and 8.0 GHz with VSWR is ≤ 2. The proposed design shows low values of Return Loss and an efficient transmission of input power.

Keywords: Wireless communication; Patch antennas; Wave transformer; Return loss; E-health

I. INTRODUCTION

Antenna is an essential part of each remote correspondence framework which gives a way to transmitting and accepting electromagnetic waves from one specialized gadget to other. Contemporary advancements in wireless correspondence have expanded the interest for multiband antenna working with variable frequencies with adequate data transfer capacity.

The smaller scale strip patch radio wire (MPAs) Microstrip Patch Antennas have an extensive variety of uses in remote or satellite correspondence because of decrease in size, low power utilization and savvy. Micro strip patch antenna comprises for the most part of three layers, a radiator with the antenna component shape, a dielectric substrate and a base metallic layer called the ground plane. Antennas are much simple to plan and manufacture on account of their basic and conservative design. They are light in weight, smaller in size and have the ability to coordinate with other microwave circuits. The little size of MPAs regularly consolidated with expansive data transmission and high proficiency execution makes the antenna plan a testing errand [1-4] be that as it may, the late advances in remote correspondence frameworks, for example, 3G and 4G systems, Personal Communication System (PCS), Wireless Local Loop (WLL), Global System for Mobile (GSM) Phase I and II and so on have prompted an immense enthusiasm for small scale strip antennas. These have grown enormously as of late because of their capacity to react to the specific requirements of size, weight and particularly cost forced by the developing versatile mobile frameworks [5].

Likewise, these antennas have the benefits of being created in substantial amounts and requiring little to no effort. One of the disadvantages of patch antenna is their limited data transmission because of surface wave losses and misfortunes along with substantial size of patch for better execution.

Moreover, attention and likeness for multi-band antennas is expanding, particularly so as to lessen the quantity of antenna apparatuses implanted in joining numerous applications on a solitary antenna. To answer this, few systems are utilized. With the advancement in the field of remote versatile correspondence like mobile communications, numerous researchers began to plan multi band MPAs which spread GSM900, 1800, 1900, WLAN, PCS, DCS and so forth. Numerous strategies, for example, fractal-shapes [6-10] stacked components [11] shorting pins [8,9] ground plane slots [12,13] and PIFA [14-16] are being utilized to outline multiband MPAs. A portion of the outstanding past works in the field of smaller scale antennas are depicted here.

Because of the impediment of paper length, keep this review brief here, however intrigued peruses are alluded to take after the references given toward the end of the paper. In [17-22], the writers introduced double band opening antennas especially for WLAN applications. In particular, in [21], the researcher displayed double band opening antenna comprising of two tight direct spaces linear slots working at 2.4 GHz and 5.2 GHz. In [22], the researcher introduced dual band equilateral-triangular space antenna working at WLAN frequencies.

Previous research work shows that the proposed antennas are fit for working at two frequencies though our suggested antenna design is equipped for working at six unique frequencies, giving a chance to be a contender for immense applications. Additionally we utilized diverse method (rectangular spaces slots) to get multi band recurrence frequency operation. Whatever remains of the article is organized as under. Area II exhibits the geometry and configuration of the proposed multiband patch antenna. Segment III displays the idea of Quarter Wave transformers (QWT). Area IV provides with calculations, measures and considerations At last, Section V is the conclusion of this paper.

II. ANTENNA DESIGN AND METHODOLOGY

In this segment, the definite outline and geometry of the proposed Multiband patch antenna. The proposed MPA 2 is planned on the FR-4 substrate with the relative permittivity $\varepsilon_r = 4.4$ and the loss tangent of tan δ = 0:02- > 0.02. The measurement of the proposed antenna on account of length and width is 40 × 35 mm. Copper tape of thickness 0.05 mm is utilized to print the patch and ground plane of antenna. Antenna graph is appeared in Figure 1.

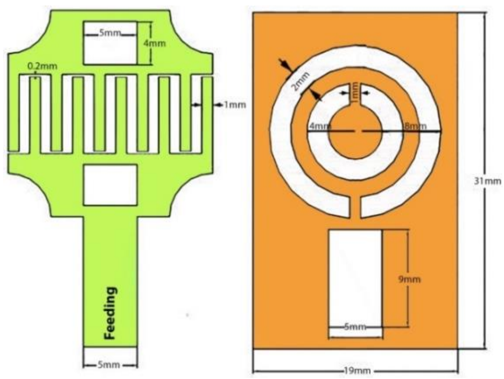
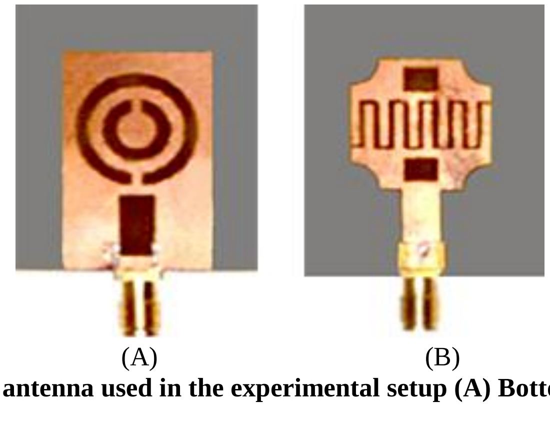


Figure 1: Configuration of the proposed antenna.

Different outline parameters with their measurements of the proposed antenna clarified in Figure 1. For the most extreme and maximum power transmission into the antenna, impedance coordinating of transmission line (normally known as feeder line) with the antenna is an important and vital step. Keeping in mind the end goal to accomplish this research, the suggested antenna is feed with the feeder line that comprises of two unique measurements and subsequently providing 50Ω impedance coordinating with the antenna (Figure 1). Configuration and arrangement of the proposed antenna (Figure 2). Fictitious proposed antenna utilized as a part of the experimental and trial setup.



(A) (B)

Figure 2: A fabricated proposed antenna used in the experimental setup (A) Bottom view (B) Top view of antenna.

III. QUARTER WAVE TRANSFORMER

When the impedance of a heap is same as the trademark impedance of the transmission line i.e., there is no reflected wave and all the info force is scattered at the heap. There are numerous approaches to accomplish this impedance coordinating. One of them is an exhibited method called Quarter-Wave Transformer.

$$Z_{in} = Z_T \frac{Z_L + jZ_T \tan(\beta l)}{Z_T + j_{ZL} \tan(\beta l)} = \frac{Z_T^2}{Z_L} \quad (1)$$

A Quarter Wave transformer (QWT), like low frequency transformers, changes the impedance of the load to another value so that coordinating is conceivable. A quarter wave transformer utilizes an area of the line of trademark impedance Z_T= l= $(\lambda/4)$ long [2]. To have a coordinating condition, Z_{in}=Z_o. As realize that the info impedance of QWT can be computed as [2]. In the instance of a QWT, $Z_T = l = (\lambda/4)$ i.e., quarter of the wavelength (λ).

Thus, $\tan(\beta l) = \tan\left(\frac{2\pi}{\lambda}\right)\left(\frac{\lambda}{4}\right) = \tan\left(\frac{\pi}{2}\right) = \infty$ Further, if Z_o=Z_{in}, then Equation (1) infers

$Z_T^2 = Z_o Z_L \gg Z_T = \sqrt{Z_o Z_L}$ .Through this QWT strategy, on the off chance $(\lambda/4)$ feeder line must be utilized then it can get a most extreme coordinating in this proposed radio wire. Subsequently greatest piece of information force will be transmitted resultant as a most extreme radiation.

IV. RESULTS AND DISCUSSION

This segment displays the numerical aftereffects of the proposed small scale strip patch antenna. HFSS programming utilized to stimulate this suggested antenna.

4.1. A Combine Effect of Creating Slot on Antenna

A Combine Effect of Creating Slots on the Patch. The recreation and simulation was done with making two rectangular and four roundabout circular slots on the radiator side of the antenna (patch). The measurement of rectangular spaces on account of length and width is 4 × 5 mm. Every round space at the four corners of the patch has span of 2.5 mm. The purpose of this procedure was just to check the conduct of return loss while presenting the openings and the outcome is shows in Figure 3. Corner truncation procedure is utilized to move the frequency at higher qualities [10]. A graphical clarification of this phenomenon is appeared in Figure 3.

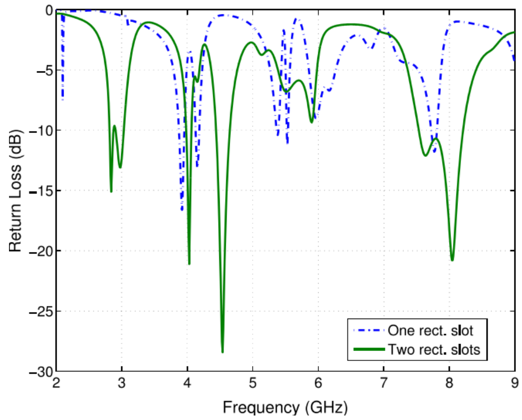


Figure 3: Effect of return loss of the proposed antenna due to the slots on the patch.

Two corner truncation with one rectangular space slot moved the frequency from lower to higher band with the change in return of the loss. So one by one corner truncation procedure was done to watch the conduct of return losses. Return losses change was seen after the truncation of every one of the four corners of the patch and making two rectangular openings slots as appeared in Figure 4. The adjustment in the conduct of return loss is because of the present dispersion on the patch surface (Figure 4). Impact of Return Loss of the proposed antenna because of the spaces/slots on the patch B. Return Loss of Proposed Antenna. The proposed antenna was analyzed and simulated by utilizing HFSS Between the frequencies 2-9 GHz.

4.2. Return Loss of Proposed Antenna

The return loss of the rectangular openings slots multiband patch antenna is appeared in Figure 4. Clearly the loss is lower than - 10 dB at 2.8 GHz, 2.9 GHz, 4.0 GHz, 4.5 GHz, 7.6 GHz and 8.0 GHz working recurrence groups. The most extreme and least return loss for this outline is - 28 and - 13 dB for the groups revolved around 4.5 GHz and 2 .9 GHz individually. The - 10 dB return loss indicates the amount coordinating and matching offers by introducing patch antenna for various groups of frequencies. The outcomes are abundantly fulfilled for various remote applications, for example, 3G, 4G, Bluetooth, PCS, and WLAN, radar, WLL, Wi-Fi and satellite correspondence. The propose antenna is additionally a decent possibility for e-Health applications like as microwave imaging on account of a decent coordinating reception apparatus comes about (Figure 4). Simulated and measured (exploratory) consequences of Return loss of proposed radio.

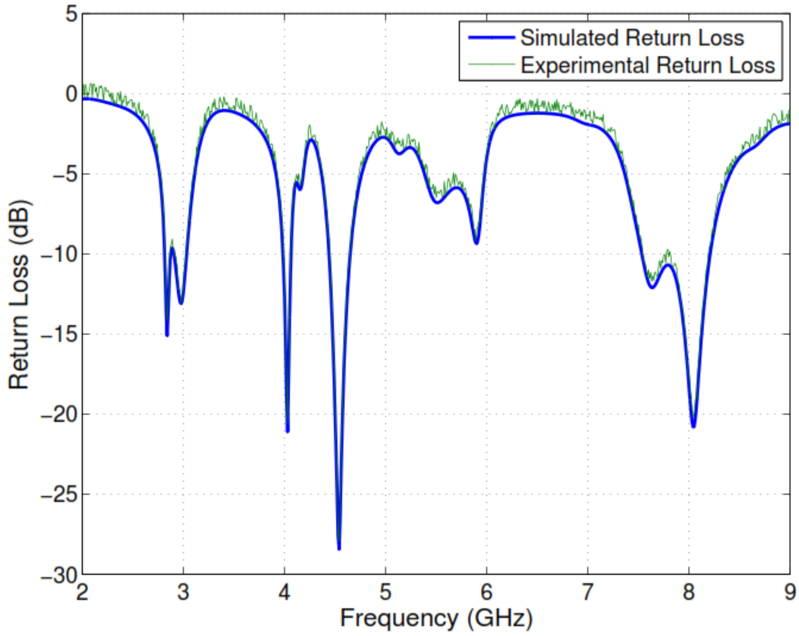


Figure 4: Simulated and measured (experimental) results of return loss of the proposed antenna design.

4.3. Voltage Standing Wave Ratio (VSWR)

Wire plan C. Voltage Standing Wave Ratio (VSWR) VSWR is an essential parameter to gauge the force transmission proficiency of a reception antenna. VSWR mirrors the jumble between the transmission line and the reception antenna. In the event that we speak to the reflection coefficient by Γ", then VSWR can be characterized as

$$VSWR = \frac{1+|\Gamma|}{1+|\Gamma|} \quad (2)$$

The base estimation of VSWR is 1.0 which is a perfect quality and it implies that no force is reflected over from the reception antenna and all supplied force is transmitted through the supplied power. Clearly accomplishing the perfect value in handy frameworks is unrealistic. Be that as it may, in the antenna outline and design, lower estimation of VSWR demonstrates better antenna plan. Figure 5 demonstrates the VSWR execution of the proposed antenna at different working frequencies. When all is said in done, there are vacillations in VSWR of the proposed antenna, yet at frequencies of interest, the VSWR is near solidarity which demonstrates that the proposed antenna is streamlined at these frequencies. The VSWR result additionally fulfils the information got by return losses appeared in Figure 4 where it is obvious that as the arrival losses rots at particular frequencies, VSWR of the proposed antenna goes near unity also. We can likewise concentrate on the coordinating results from VSWR of the proposed antenna, which demonstrates a decent coordinating (with the transmission line) patch antenna. Such kind of antenna is a helpful and valuable in different remote correspondence frameworks, microwave imaging innovation i.e., as bosom growth identification and e-Health applications because of its protected correspondence (Figure 5).

VSWR of proposed antenna plan.

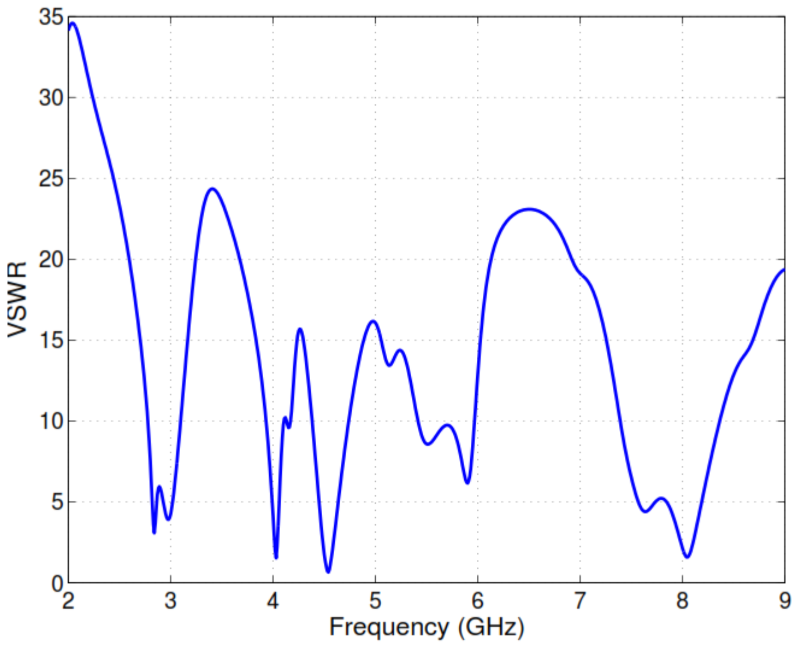


Figure 5: VSWR of proposed antenna design.

V. CONCLUSION

A multiband smaller scale strip patch antenna is composed and created to examine the execution for various remote applications. The configuration comprises of two rectangular openings slots on patch with corner truncation on the patch and ground surfaces as well. Thus, these strategies make an antenna advantageous for multiband operations. Six thunderous frequencies are accomplished through proposed antenna plan. The booming frequencies happened in the scope of 2 - 9 GHz. The most extreme and least return loss for this configuration is - 28 and - 13 dB for the groups based on 4.5 GHz and 2 .9 GHz separately. Additionally, the VSWR of proposed antenna is ≤ 2 with high antenna effectiveness. The proposed antenna has numerous applications, for example, Wi-Fi, 3g, 4G, WLAN, Bluetooth, PCS, Radar, DCS and satellite correspondence .The exhibited antenna is very easy to make and it is cost effective and savvy as well.

REFERENCES

1. Balanis CA, Antenna theory: Analysis and Design, John Wiley & Sons, Inc., ISBN 0-471-66782-X, NewYork, USA 2005.
2. Pozar D, Schaubert D, Microstrip Antennas: The Analysis and Design of Microstrip Antenna Arrays. Wiley-IEEE Press 1995.
3. James JR, Hall PS, Handbook of micro-strip antennas. I.E.E. Electromagnetic Waves Series 28–Peter Peregrines LTD, 1989.
4. Best SR, Electrically Small Multiband Antennas, In: Multiband Integrated Antennas for 4G Terminals, D. A. Sanchez-Hernandez (ed.), 1-32, Artech House, ISBN 978-1-59693-331-6, Boston, USA. 2008.
5. Anguera J, Daniel JP, et al. Metallized Foams for Antenna Design: Application to Fractal-Shaped Sierpinski-Carpet Monopole. Progress in Electromagnetics Research, PIER 2010; 104: 239-251.
6. Risco S, Anguera J, et al. Coupled Monopole Antenna Design for Multiband Handset Devices. Microwave and Optical Technology Letters 2010; 52: 359-364.
7. Aouadi B, Tahar JB, Requirements Analysis of Dual Band MIMO Antenna. Wireless Personal Communications 2015; 82: 35.
8. Kang DG, Lee JH, et al. Coupled-Fed Planar Monopole Antenna for LTE/WWAN Mobile Handset Applications. The Journal of Korean Institute of Electromagnetic Engineering and Science, 2013; 24: 475.
9. Anguera J, Puente C, et al. Dual Frequency Broadband Micro-strip ntenna With a Reactive Loading and Stacked Elements. Progress in Electromagnetics Research Letters 2009; 10: 1-10.
10. Mandloi M, Hussain MA, et al. Adaptive multiple stage K-best successive interference cancellation algorithm for MIMO selection. Telecommunication system, 2017.
11. Bashar F, Thushara D, Abhayapala, Performance analysis of spatially distributed MIMO systems. IET Communication, 2017; 11: 566.
12. Hua Y, Zhao G, et al. Modified code words design for space–time block coded spatial modulation. IET Communications,

2017; 11: 249.
13. Nguyel VA, Bhatti RA, et al. A simple PIFA- based tunable internal antenna for personal communication handsets IEEE Antennas Wireless Propag. Lett 2008; 7: 130-133.
14. Aziz ul Haq M, Khan MA, et al. A Novel compact Antenna design for Secure eHealth Wireless Communications, 17th IEEE/ACIS international Conference on software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD) 2016; 281-286.
15. Ulhaq MA, Khan MA, A Multiple Ring Slots Ultra-Wide Band Antenna (MRS-UWB) for Biomedical Application, 17th IEEE International Multi-Topic Conference (INMIC) 2014; 56-60.
16. Mandloi M, Hussain MA, et al. Improved multiple feedback successive interference cancellation algorithms for near-optimal MIMO detection. IET Communications, 2017; 11:150.
17. Immadi G, Swetha K, et al. Design of micro-strip patch antenna for WLAN applications using Back to Back connection of Two E-Shapes. International Journal of Engineering Research and Applications 2012; 2: 319-323.
18. Nguyel VA, Bhatti RA, et al. A simple PIFA-based tunable internal antenna for personal communication handsets. IEEE Antennas Wireless Propag. Lett 2008; 7: 130-133.
19. Wang E, Zheng J, et al. A novel dualband patch antenna for WLAN communications. Progress in Electromagnetic Research 2009; 6: 93-102.
20. Wang CJ, Chang SW. Studies on dualband multi slots antenna. Progress in Electromagnetic Research 2009; 83: 293-306.
21. Su CM, Chen HT, et al. Dualband slot antenna for 2.4/5.2 GHz WLAN operation. Microwave and Optical Technology Letters 2002; 35: 306-308.
22. Bai L, Zhu L, et al. Cooperative transmission over Rician fading channels for geostationary orbiting satellite collocation system. IET Communications 2017; 11: 538.