A CIRCULAR RING PATCH ANTENNA FOR WIRELESS APPLICATIONS

L. Nageswara Rao¹, G. Nanda Kishore² and A. Karthik Sagar³

¹,²,³Department of Electronics and Communication Engineering, CVR College of Engineering, Hyderabad, India

Abstract—In this paper, a compact circular ring microstrip patch antenna using adaptable FR4 as substrate has been designed. The proposed antenna configuration was intended to work at the centre frequency of 5.29 GHz for Wireless Local Area Network (WLAN) applications. The antenna comprises circular microstrip patch along with an embedded circular slot in the patch centre. The geometry resonates at a UNII band which completely covers the 5.175–5.725 GHz WLAN band. A microstrip feed line is utilized to acquire impedance coordinating over a wide band of frequencies. The return loss impedance transmission capacity values are enhanced significantly for desired resonant frequencies. Designed antenna is described with better radiation patterns and potentially stable gain around 2-3dBi over the working bands. The proposed antenna parameters are analysed by the simulation of the structure with high frequency structure simulator (HFSS). The designed antenna structure is reasonable for wireless LAN applications.

Keywords—Microstrip patch antenna (MPA); circular ring patch antenna; microstrip feed line; WLAN.

I. INTRODUCTION

In recent years, microstrip antenna[1], [3]s have excited great interest in both theoretical research and engineering applications because of their low profile, conformal structure, and ease in fabrication and integration with solid-state devices. As a result of the innate thin transfer speed of microstrip reception apparatuses, many endeavors have been made to enhance their transmission capacity qualities. In general, there are two productive ways to deal with widen the transmission capacity of the microstrip radio wires, i.e., by increasing the substrate thickness and by creating the slots [2], [4] on the same or different layers of an antenna structure. The different types MPAs such as circular ring, circular, rectangular, squares and ring slot shapes [1]-[5] have been portrayed in literature. Circular ring patch antennas [6] – [9] are having attractive features over the square slot shapes.

In traditional WLAN, IEEE 802.11 [6] principles are generally embraced for correspondences over a distance of a few many meters. In the current time of cell communication, low profile reception apparatus with high productivity is broadly required. Mobile communication plays a vital role in the human life. The most widely recognized portable applications utilized as a part of recent years is WLAN. A lot of research works have been directed on WLAN radio wires at 5.2 GHz [14]. WLAN (Wireless Local Area Networks) is a remote PC organize that connections at least two gadgets utilizing a remote appropriation technique inside a limited region, for example, a home, school, computer laboratory, or office building. This gives users the ability to move around within a local coverage area and still be associated with the system and can give an association with the more extensive Internet. WLAN is intended to work in the frequencies groups 5.15–5.725 GHz (802.11a/h/n). Later on, a cell phone ought to be more versatile to the flag condition and able to switch between high information rate short-go associations (HYPER LAN) and customary associations.

A compact ring patch antenna [10] in feeding models need, standardized knowledge to couple the resonators and elements. However, the resonant feeding framework set in these portrayed models, such as microstrip-fed, aperture-coupled, co-axial probe coupling, co planar slot feed and CPW-fed space course of action offers greater adaptability and is specifically perfect with various mounting surfaces. In this structure, in order to avoid via holes, the microstrip feed line is suggested [15]. The microstrip line set on a similar substrate of round ring patch that could be put straightforwardly on the feed line. The benefit of microstrip feed is easy to coordinate by controlling the inset encourage position.
A compact circular ring patch antenna [11]-[13] is designed for HYPER LAN applications and the proposed antenna model is fed with microstrip feed line. It consists of UNII band (5.29 GHz) of circular ring patch antenna and it is controlled by the radius of the circular slot. In this model, a microstrip line is presented on a same substrate for good impedance matching. The favorable position of microstrip feed is that it is less difficult to make, match and model.

The physical and analytical parameters of these models are varying correspondingly to get the aimed execution parameters. In this model, improvement of round ring patch receiving wire is executed for the UNII band which will be sensible for remote neighborhood applications. This outline has the benefit of straightforward structure, conservative size, and can acquire UNII band with various emanating designs and the actualized antenna model is intended to work at the centre frequency of 5.29 GHz for wireless local area network applications.

II. ANTENNA CONFIGURATION

A compact circular ring patch antenna fed by microstrip line is proposed [12]. The designed antenna model comprises the circular ring patch antenna at centre position of substrate. The suggested circular ring patch antenna oscillates at 5.29 GHz (UNII) which is reasonable for wireless local area network applications. The circular ring patch antenna is placed on the substrate – FR4 resonate at UNII band frequencies. By varying the radiating resonators’ position and by adapting a circular slot at midpoint of circular patch, a compact circular ring patch can be designed. The feed line [15] is placed on the substrate at the centre point.

Figure 1 illustrates the designed antenna model for wireless network applications. The implemented antenna has the dimensions of 35 mm × 35 mm × 1.6 mm, and an FR-4 dielectric with a relative permittivity of 4.2 is used as a substrate. It comprises a circular ring patch with a centre-fed microstrip line which is printed on an FR-4 substrate of thickness 1.6 mm and relative permittivity $\varepsilon_r$ =4.2. The circular ring patch has a radius of $R_P$=10 mm and circular slot has a radius of $R_S$ = 6 mm as shown in Figure 1. The 50-Ω feeding line has a length of $L_f$=19 mm and a width of $W_f$=3.0 mm.

The idealized operating frequency of the circular patch antenna is determined [16] by the following equation and suitable to 5.29 GHz which is applicable for wireless LAN applications.
Where,  
\[ a = \frac{8.791 \times 10^9}{f_r \sqrt{\varepsilon_r}} \]  
\[ F = \frac{1 + \frac{2h}{\pi F \varepsilon_r} \left[ \ln \left( \frac{\pi F}{2h} \right) + 1.7726 \right]}{3/2} \]

III. SIMULATED RESULTS AND DISCUSSIONS

The simulated return loss of the intended circular ring patch antenna is as exhibited in Figure 2. The proposed energized band is a direct result of circular ring patch. The -36 dB return loss is seen at 5.29 GHz. Note that there are no frequencies to be irritated ostensibly the presence of patch resonator, that is, the full resound space mode is instigated by the circular ring patch.

The return loss is another method of communicating mismatch. It is a logarithmic proportion estimated in dB that analyzes the power reflected by the receiving wire to the power that is bolstered into the radio wire from the transmission line. The connection amongst SWR and return loss is the accompanying:

\[
\text{Returnloss}(dB) = 20 \log_{10} \frac{SWR}{SWR - 1}
\]

The term transmission capacity basically characterizes the recurrence extend over which a receiving wire meets a specific arrangement of detail execution criteria. The vital issue to consider with respect to transmission capacity is the execution tradeoffs between the greater parts of the execution properties portrayed previously.

There are two strategies for processing a antenna data transfer capacity. The antenna is viewed as broadband if \( \frac{f_H}{f_L} \geq 2 \).

Narrowband by %

\[
BW = \frac{f_H - f_L}{f_0} \times 100\%
\]
Figure 2: Simulated return loss at UNII band

The radiation waves of the simulated antenna model at 5.29 GHz with phi=0 (deg) and phi = 90 (degree) is exhibited in Figure 3. The antenna emanates a most extreme in the broadside bearing at 5.29 GHz, which oscillates to the far-field radiation from the enhancement method of the circular ring patch as shown in Figure 3. The radiation pattern of antenna gives the data that depicts how the reception apparatus coordinates the vitality it transmits. All antennas, if 100% efficient radiate the same total energy for equal input power regardless of pattern shape.

Figure 3: Simulated radiation patterns at UNII

The voltage standing wave ratio (VSWR) of the proposed model is as exhibited in Figure 4. It represents the analysis of the mismatch between the load and the transmission line. For good impedance matching, the significant value of VSWR is 1. The VSWR of proposed model is 1.03 at 5.29 GHZ. The VSWR indicate that how closely or efficiently an antenna’s terminal input impedance
is matched to the characteristic impedance of the transmission line. By using VSWR, mismatch between the transmission line and antenna can be analyzed.

Figure 4: Simulated VSWR at UNII

Figure 5 exhibits the gain of the designed antenna, the peak gain of the designed antenna is 2.57 dBi at 5.29 GHz. Because the maximum radiation is directed towards 5.29 GHz UNII band, the proposed antenna model is reasonable for the wireless applications.

Figure 5: Simulated Gain at UNII
IV. CONCLUSION

A compact dual band circular microstrip patch antenna with a parasitic-slot sustained by a microstrip line has been designed. The primary and secondary bands of the circular patch antenna are implemented by the parasitic-slot and circular patch modes, correspondingly. A parametric report is done to explore the antenna functional and design parameters. The model has been reproduced and it is watched that a transmission capacity and return loss of 4.25%, 5.15% and -34 dB, -37 dB at the resonant frequencies of 2.4 GHz and 5.2 GHz correspondingly. The designed model takes a less volume, compact size, simple shape and adequate operational bandwidth, such that it is suitable for wireless local area network applications.

REFERENCES

[1] Sekhar M, S. N. Bhavanam, Dr. P. Siddaiah, “Triple Frequency Circular Patch Antenna”, IEEE International Conference on Intelligence and Computing Research, pp. 1-3, December 2014

[2] R. Srivastava, S. Ayuh, V. K. Singh, J. P. Saini, “Dual Band Rectangular and Circular Slot Loaded Microstrip Antenna for WLAN/GPS/ WiMax Applications”, Fourth International Conference on Communication Systems and Network Technologies, pp. 45-48, April 2014

[3] S. I. Hussain Shah, S. Bashir, S. D. Hussain Shah, “Compact Multiband microstrip patch antenna using Defected Ground structure (DGS)”, The 8th European Conference on Antennas and Propagation (EuCAP), pp. 2367-2370, April 2014

[4] M. I. Sabran, S. K. A. Rahim, M. F. M. Yusof, A. A. Eteng1, M. Z. M. Nor, I. M. Ibrahim, “Miniaturized Proximity Coupled Antenna with Slot Ring as Defected Ground Structure”, IEEE Symposium on Wireless Technology and Applications (ISWTA), pp.81-85, Sept-Oct 2014

[5] U. Chakraborty, A. Kundu, S. K. Chowdhury, A. K. Bhattacharjee, “Compact Dual-Band Microstrip Antenna for IEEE 802.11a WLAN Application”, IEEE Antennas And Wireless Propagation Letters, Vol.13, pp.407-410, February 2014

[6] M. H. Tariq, S. Rashid, F. A. Bhatti, “Dual Band Microstrip Patch Antenna for WiMAX and WLAN Applications”, International Journal of Multidisciplinary and Current Research, vol.2, pp. 104-108, Jan-Feb 2014

[7] S. C. Gao, L. W. Li, T. S. Yeo, M. S. Leong, “Small Dual-Frequency Microstrip Antennas”, IEEE Transactions on Vehicular Technology, vol.51, No.1, pp. 1916-1917, January 2002

[8] H. A. Atallah, A. B. Abdel-Rahman, K. Yoshitomi, R. K. Pokharel, “Design of Dual Band-Notched CPW-Fed UWB Planar Monopole Antenna Using Microstrip Resonators”, Progress In Electromagnetics Research Letters, vol. 59, pp.51–56, 2016

[9] W. C. Liu, C. M. Wu, Y. Dai, “Design of Triple-Frequency Microstrip- Fed Monopole Antenna Using Defected Ground Structure”, IEEE Transactions on Antennas And Propagation, vol.59, No.7, pp. 2457-2463, July 2011

[10] Garima, D. Bhatarang, J. S. Saini, V. K. Saxena, L. M. Joshi, “Design of Broadband Circular Microstrip Patch Antenna With Diamond Shaped Slot”, Indian Journal of Space And Physics, vol.40, pp.275-278, October 2011

[11] J. A. Ansari, A. Mishra, N. P. Yadav, P. Singh, “Dualband Slot Loaded Circular Disk Patch Antenna for WLAN Application”, International Journal Of Microwave And Optical Technology, vol.5, No.3, pp. 124-129, May 2010

[12] G. P. Gao, M. Li, S. F. Niu, X. J. Li, B. N. Li, J. S. Zang, “Study Of Novel Wideband Circular Slot Antenna Having Frequency Band Notched Function”, Progress In Electromagnetic Research (PIER) 96, pp. 141-154, 2009

[13] C. J. Wang, S. W. Chang, “Studies On Dual-Band MULTI-Slot Antennas”, Progress In Electromagnetics Research, PIER, vol. 83, pp. 293-306, 2008

[14] Q. Zhong, Y. Li, H. Jiang, Y. Long, “Design of a Novel Dual-frequency Microstrip Patch Antenna for WLAN Applications”, Antennas And Propagation Society International Symposium, vol.1, pp. 277-280, June 2004

[15] R. A. Kranenburg and S. A. Long, , “Microstrip Transmission Line Excitation of Dielectric Resonator Antennas,” Electron. Lett. vol. 24, pp.1156-1157, 1988

[16] C. A. Balanis, “Antenna Theory, Analysis and Design”, Second edition, John Wiley and Sons, New York, 1997