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A Compact Microstrip Patch Antenna for RFID and WLAN Applications

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Abstract – ***This paper presents the design and simulation results of a very compact microstrip patch antenna for Radio Frequency Identification (5.8 GHz) and WLAN (5.12 GHz) applications. The proposed antenna has been designed and simulated using Fire Resistant FR4 Epoxy substrate. The patch dimensions are 29.7 x 36 x 1.5 mm³ and has a Microstrip Line feed. The antenna has a low return loss of about -38.06 dB with VSWR of almost 1.02 and a good directivity of 11.1 dBi at 5.8 GHz and it has return loss of -15.43 dB, VSWR of 1.4 and directivity of 7.37 dBi at 5.12 GHz. The performance of the proposed antenna is analyzed as well as compared with other RFID antennas at ISM band. It is designed and simulated in CST Microwave Studio software.***

Key Words: Microstrip patch antenna, WLAN, Directivity, RFID, Compact

1. INTRODUCTION

Antennas play a very important role in the field of wireless communications. During the recent years, microstrip antennas have attracted an important interest in modern communication systems because of their significant characteristics of small size, light weight, low cost on mass production and thin profile [1]. They are also compatible with wireless communication integrated circuitry due to their simple feed methods, especially microstrip-line and coplanner waveguide feeds. However, their capability to operate at a single frequency, narrow bandwidth and low gain when comparing it with other microwave antennas restrict their practical applications [2].

Because of the low profile and compact size of the planar and printed antennas, there is a strong preference to this type of antennas for applications such as WLAN, UWB, LTE and RFID. Modern mobile and wireless communication systems require compact size, broadband and dual/multi frequency antennas, thus the possibility to apply these antennas for modern communication systems is reinvestigated by applying modifications in their patch geometries [3].

Wireless technology advancements have given birth to radio frequency identification (RFID) systems, which have generated significant interest and hype among scientists, researchers and industry [4]. RFID technology enables identification, location and information exchange of distant objects via radio waves. It has been commercialized in areas of logistics, manufacturing, transportation, health care, and mobile communications [5]. Basically RFID system is a tag or transponder and a transceiver or reader. The tag consists of an antenna combined with an application-specific integrated circuit (ASIC) chip. In order to activate and detect a tag, a base station (reader) transmits a modulated signal with periods of unmodulated carrier [5, 6, 7].

Most of the RFID applications works with a bandwidth of around 180 to 300 MHz for different bands such as Low Frequency (LF) band of 120-150KHz, High Frequency (HF) band for 13.56 MHz, Ultra High Frequency (UHF) for 860 MHz to 960MHz and Microwave (MW) band for 2.45 GHz or 5.8 GHz [8]. The microwave bands are popular than other RFID bands in many areas because of its high readable range, fast reading speed, large information storage capability [9].

Many attempts have been made in recent times to reduce the antenna size. A Patch antenna with a large dimension working in ISM band was proposed in [10]. A low power slotted patch antenna for RFID tag reader applications was proposed in [11] which has an operating frequency band of 2.3-2.4 GHz. A tag antenna mountable on objects was proposed in [12] which has a bandwidth of 37 MHz and Power transmission coefficient of 0.86. In [13], a novel circularly polarized asymmetric circular shaped slotted patch antenna was proposed for the UHF RFID handheld reader applications. A new type of compact slotted microstrip patch antenna was proposed in [14], which consists of a slot cut in the ground plane of the antenna and produces gain of 2.5 dB.

In this paper, a compact and dual band microstrip patch antenna for RFID applications resonating at 5.8 GHz ISM band and 5.12 GHz for WLAN applications is presented. For the purpose of matching the antenna to 50Ω impedence of the feed line, the length of the feed line has been modified with respect to the actual calculated value. The proposed antenna will be compact, light weight and slim. The theoretical simulations are performed using CST software.

2. ANTENNA DESIGN

2.1 Design Equations

Microstrip patch antenna is used at 5.12 GHz and 5.8GHz as resonance is achieved at these points and is fed with a microstrip feed line. The design of the proposed microstrip patch antenna was modeled using the classical equations:

Step 1: Calculation of the Width (W):

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

where, $c = 3 \times 10^8$ m/s, $\varepsilon_r = 4.4$, f = Designed Frequency

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \left(\frac{\varepsilon_r - 1}{2}\right) / \left(\sqrt{1 + \frac{12h}{w}}\right) \quad (2)$$

where, h = 1.5 mm

Step 3: Calculation of the Effective length (L_{eff}):

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}} \quad (3)$$

Step 4: Calculation of the length extension (ΔL):

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)(\frac{w}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{w}{h} + 0.8)} \quad (4)$$

Step 5: Calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L \quad (5)$$

Step 6: Calculation of the length and width of substrate:

$$L_g = 6h + L \quad (6)$$
$$W_g = 6h + w \quad (7)$$

TABLE I: Antenna Design Specification

Parameters	Value in mm
Lg	61.7
Wg	89
h	1.5
L	29.7
W	36
Lf	2.83
Wf	26.5

2.2 Model and Geometry of the proposed antenna

The design of the proposed antenna is shown in Figure (1). This figure shows the microstrip rectangular patch antenna and microstrip feed line is used to excite the antenna. The antenna is fabricated on FR4 substrate with a thickness of 1.5 mm, permittivity of 4.4 and tangential loss of 0.025. It was necessary to vary the dimensions of the patch to get the desired output. For the purpose of matching the antenna to 50 Ω impedence of the feed line, the length and width of the feed line was varied. For impedence matching, the width of the feed line has been kept at a value greater than its length.

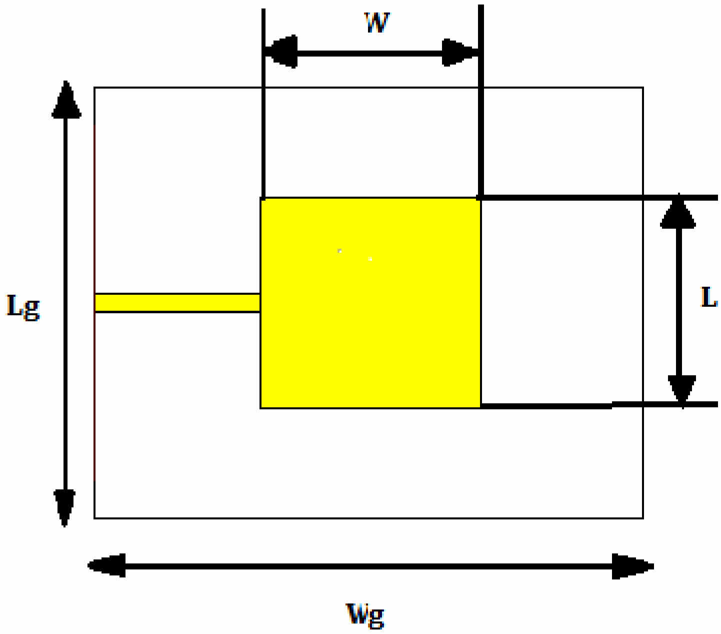

Fig-1: Top view of antenna

3. SIMULATIONS AND RESULTS

From the data calculated and optimized, the proposed antenna has Patch dimensions equal to $29.7 \times 36 \times 1.5$ mm^3. The antenna dimensions are pretty compact as compared to the design in [10]. The comparison between [10] and the proposed antenna at 5.8 GHz is tabulated in Table II;

TABLE II: Comparison between [10] and the proposed antenna

Parameters	Reference paper [10]	Proposed antenna
Dimensions	105×165.5mm^2	61.7×89 mm^2
Return loss	-31.42 dB	-38.06dB
VSWR	1.055	1.02
Gain	6.5 dB	4.4 dB

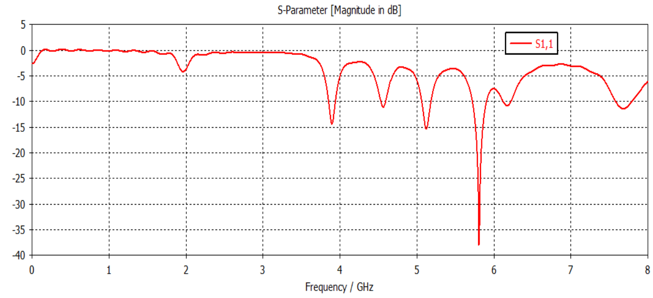

Fig-2: Simulated return loss of the proposed antenna

The simulation of the proposed antenna is done using CST software. From Fig-2, it can be seen that the minimum return loss value of the proposed antenna is about -38.06 dB at 5.8 GHz ISM band. It has a -10 dB bandwidth of 185.8 MHz at 5.8 GHz resonant frequency which reveals that the designed antenna is suitable for the RFID applications. At 5.12 GHz resonant frequency, the return loss is found to be -15.43 dB having a -10 dB bandwidth of 120.8 MHz.

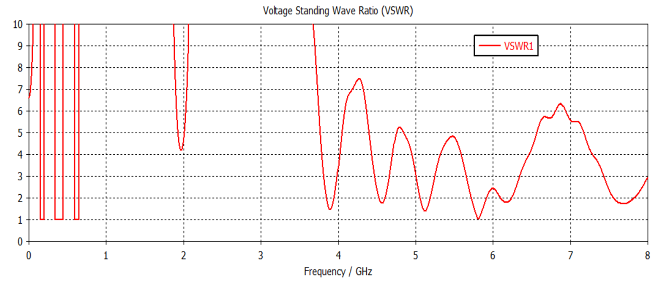

Fig-3: VSWR of the proposed antenna

The Voltage Standing Wave Ratio (VSWR) plot obtained from the simulation of designed antenna is shown in Fig-3. The antenna has a VSWR of 1.02 at 5.8 GHz which is very near to the desired value of unity and at 5.12 GHz resonant frequency, the VSWR is about 1.4.

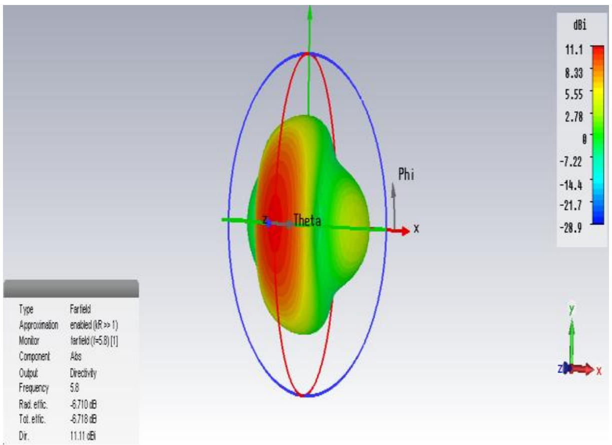

Fig-4: Radiation pattern at 5.8 GHz with directivity 11.1 dBi

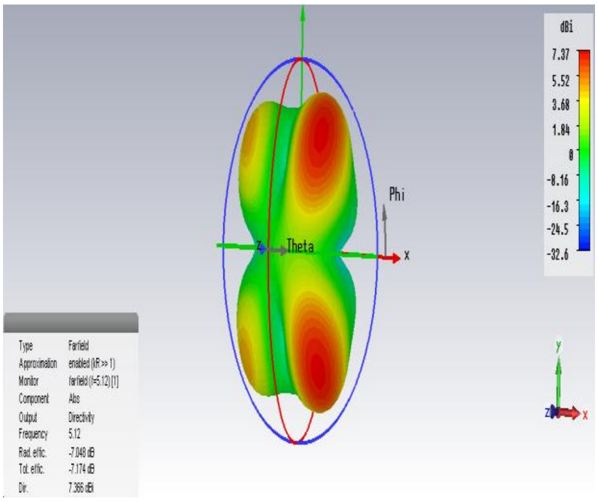

Fig-5: Radiation pattern at 5.12 GHz with directivity 7.37 dBi

Fig-4, 5 shows the radiation pattern of the proposed antenna at 5.8 GHz and 5.12 GHz. From the figure, it can be seen that the directivity of the antenna at 5.8 GHz is about 11.1 dBi and 7.37 dBi at 5.12 GHz.

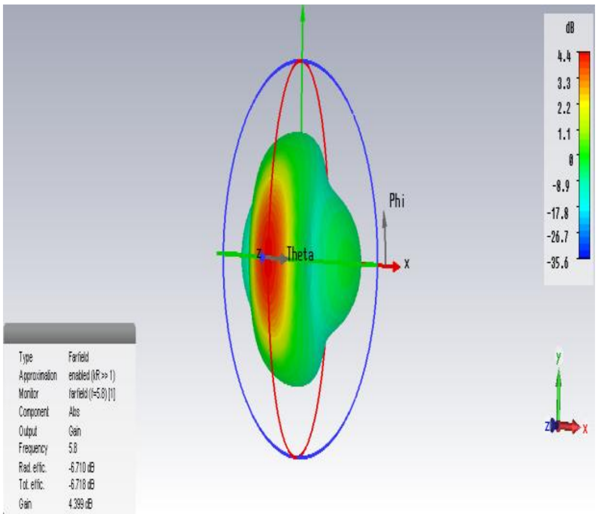

Fig-6: Far-field view for Gain

Fig-6 shows the gain of the proposed antenna at 5.8 GHz. It can be observed from the far-field view that the gain obtained at 5.8 GHz is about 4.4 dB.

4. CONCLUSION

Microstrip antenna has become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size and ease of manufacturing. In this paper, a compact dual band microstrip patch antenna for RFID and WLAN applications is reported. The antenna has been designed and simulated using Computer Simulation Technology (CST) software. The designing has been done such that we have a reduction in size of the antenna and good directivity. The antenna is thin and compact with the use of low dielectric constant substrate material. These features are very useful for worldwide portability of RFID and wireless communication equipment.

REFERENCES

[1]. Balanis C. A, "Microstrip Antennas", Antenna Theory, Analysis and Design, Third Edition, John Wiley & Sons, pp-811-876, 2010.

[2]. S. A. Schelkunoff, H.T.Friss, Antennas: Theory and Practice, New York: John Willy & Sons, 1952.

[3]. R.A.R Ibrahim, M.C.E. Yagoub, R.W.Y. Habash, "Microstrip Patch Antenna for RFID Applications", pp. 940-943, 3-6 May 2009.

[4]. Md. Ashikur R., A. Shaikat, Iqbal, Asif Hassan, "Microstrip Patch Antenna Design and Performance Analysis for RFID applications at ISM band (2.45 GHz)", (ICAEE 2013), pp. 305-308, 19-21 December, 2013, Dhaka, Bangladesh.

[5]. R.A.R. Ibrahim, and Yagoub, "Practical Novel Design Component of Microstrip Patch Slot Antenna MSPSA for RFID Applications", CCECE, pp. 1-5, 2-5 May 2010.

[6]. Rajesh Saha and Maity, "Enhancement of gain, bandwidth and directivity of a patch antenna by increasing dielectric layers of the substrate through micromachining technique for RFID applications", International Conference on Advances in Computer Engineering and Applications (ICACEA) , pp. 321-324, 2015, IMS Engineering College, Ghaziabad, India.

[7]. Shankar Bhattacharjee, Rajesh Shah, and Santanu Maity, "Metamaterial based patch antenna with omega shaped slot for RFID system", (ICAETR-2014), pp. 1-5, August 01-02, 2014, Dr. Viirendra Swarup Group of Institutions, Unnao, India.

[8]. J. Wu, J. Li, X. Cui, L. Mao, "Miniaturized Dual-Band Patch Antenna Mounted on Metallic Plates for RFID Passive Tag", International Conference on Control, Automation and Systems Engineering (CASE), pp. 1-4, 2011.

[9]. A. Maria, V. Vishnupriya, K.K.A. John, T. Mathew, "Dual band circularly polarized truncated patch antenna for RFID reader and WiMAX applications", 2nd International Conference on Electronics and Communication Systems (ICECS), pp. 684-687, 2015.

[10]. Bhushan, Deepak C. Kaira, "A 5.8 GHz ISM band Microstrip antenna for RFID applications", International Conference on Nascent Technologies in the Engineering Field (ICNET-2015), pp. 1-4, 9-10 Jan, 2015.

[11]. Thirumalai T., and Kashwan K.R., "Low Power slotted patch antenna for RFID tag reader applications", International Conference on Electrical, Electronics, Signals, Communication and Optimization (EESCO), pp. 1-5, 24-25 Jan, 2015.

[12]. Faudzi, M.T.Ali, I.Ismail, H.Jumaat, N.H.M.Sukaimi, "Compact Microstrip Patch UHF-RFID Tag Antenna for metal object", IEEE Symposium on Wireless Technology and Applications (ISWTA), pp. 160-164, Sept28-Oct 1, 2014, Kota Kinabalu, Malaysia.

[13]. Nasimuddin, Zhi Ning Chen, and Xianming Qing, "Asymmetric-Circular Shaped Slotted Microstrip Antennas for Circular Polarization and RFID Applications", IEEE Transactions on antennas and propagation, Vol.58, No.12, pp. 3821-3828, December 2010.

[14]. Mokhtar, M.K.A. Rahim, N.A. Murad , "A compact Slotted Microstrip Patch Antenna for RFID applications", IEEE International Conference on RFID Technologies and Applications, pp. 1-4, 4-5 September, Johor Bahru, Malaysia, 2013.