International Journal of Engineering Works
ISSN-p: 2521-2419
ISSN-e: 2409-2770
Vol. 7, Issue 07, PP. 251-254, July 2020
https://www.ijew.io/
https://doi.org/10.34259/ijew.20.707251254

Design and Analysis of Dual Band Circular Slotted Patch Antenna at 2.45GHZ and 5.8GHZ for RFID Applications

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Received: 31 May, Revised: 15 June, Accepted: 25 June

Abstract**—**In this project patch antenna has been used for Radio Frequency Identification (RFID) applications. Due to the advancement in the field of wireless communications day by day, RFID is the most attractive technology being used as an identification technology and is far better than other sources of identification and tracking i.e. Bar code technology. Different frequency bands are assigned for RFID antenna. But in this project work has been made in Microwave band ranging from (2.400- 2.483) GHz and (5.7250- 5.8750) GHz due to a number of applications and due to the higher transfer rate. In order to design slotted dual band patch for RFID 2.45GHz and 5.800 Ghz applications, a 1.58 mm thicker RT/duroid-5880 is selected for substrate material having a relative permittivity and loss tangent of ε_r=2.2 and δ=0.0009 respectively. To achieve dual band response different techniques can be adopted. First a conventional patch for 2.45GHz has been designed and then with the help of slotting techniques another frequency band was achieved that was radiating at 5.8 GHz. The dual band frequency of the antenna has been achieved by introducing the slot in the upper most layer patch with coaxial feed. The gain, efficiency and bandwidth of the antenna at (2.45 and 5.80) GHz are {6.661 dB, 89 %, 36 MHz} and {6.661 dB, 97 % and 341MHz}, respectively. The antenna can be potentially use for RFID and WLAN applications. All the simulations are carried out using CST MWS. The prototype has been fabricated to validate the results**.**

Keywords— Radio Frequency Identification (RFID), Giga hertz (GHz), Wireless lan (WLAN), Computer Simulation Technology Microwave Studio (CST MWS), Decibel (dB).

I. Introduction

Wireless communication is replacing the wired technologies. System antenna is an important module, without antenna wireless communication is impossible. Therefore the antenna must be more efficient to perform in a better way. Networked physical objects provide a great global infrastructure that connects virtually physical world with objects. Internet of Thing (IoT) is now a day's most emerging technology with very vast futuristic vision in which internet embed itself with every objects through RFID in a transparent way [1].

The clue of the identification of things and the control of remote devices through Radio frequency identifiers, (RFID's) was presented by H. Stockman in year 1948 [2]. RFID is an automated technology used for proof of identity and improved tracking of human as well as animals. It is also used for healthcare, security purposes, robotics, and collecting toll electronically vehicle speed measuring, and bioengineering [3]. It can identify, sensed object by sending a signal emerging from reader and ending at tag antenna where in the tag there is an integrated circuit (IC) where the information is stored so upon receiving an appropriate signal the information stored in the IC will send back through the tag antenna to the reader [4].

Antenna being a metallic device (as a wire or rod) while having the functionality of both receiving and transmitting electromagnetic energy. It can also be defined as something which can receive radio waves and can also radiate them [5].

According to the figure 1 ideal generator is the source.The impedance of antenna is signified by load ZA and transmission line bear connection with it, losses with in antenna is represented by RL known as dielectric losses and conduction, radiation resistance is denoted by Rr, and Xa also called reactance[5]. In ideal condition maximum power is transferred to the antenna from transmitting source. In applied systems, dielectric-losses appear in transmission line and mismatches appear between antenna impedances and antenna transmission line, which results in originating standing waves [5].

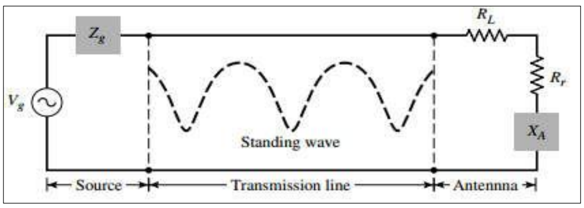

Figure 1. Thevenin & Norton of Antenna system

Less weight, small size, high performance, conformability and low cost are the key requirements of modern age and Patch antenna is the right choice. patch (antenna) contains a radiating-patch which is then attached on a dielectric layer (substrate) consequently supported by ground plane as yx

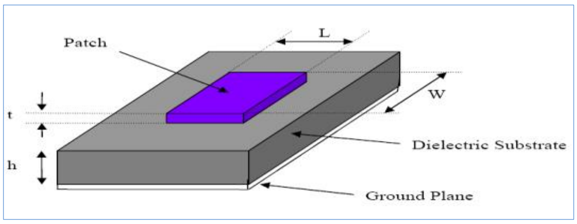

Figure 2. Microstrip patch Antenna

presented in the figure 2. Metals like copper metals or gold can be used as a patch of any shape.

The operation of conventional patch antenna can be modified also by applying the techniques of slotting in the patch. The insertion of slot will introduce perturbation of different modes. In some extent the effect of modes are dependent upon the slot shape, size and the position of the slot. As a result of inserting slot in some certain position there will be produced some more modes. Compact linear and circular polarised antennas, dual band and wideband antennas can be produce by perturbing the correct modes. There are different ways to make slots in patch [6-7].

II. ANTENNA DESIGN AND ANALYSIS

Figure 3 and 4 shows the layout and aspects of dual-band patch (antenna) for RFID 2.45 GHz and 5.8 GHz related applications. In this design a Rogers RT5880 (lossy) is used as a substrate. Relative permittivity, thickness and tangent loss of the substrate are 1.575 mm, $\varepsilon_r = 2.2$ and $\delta = 0.0009$ respectively. The conducting material of the radiating ground and patch plane is taken as low loss copper metal to get better radiation efficiency. The proposed antenna is excited by 50 Ω, 4.5 mm wide coaxial feed line. The width & length of the feed-line as shown are calculated using the standard Transmission-line theory. Slots we introduced to get the desired frequencies, dimensions of the slots can be seen in the same figure [8].

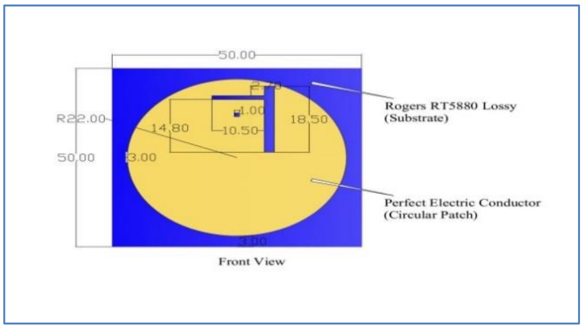

Figure 3. Front View of Antenna

Width equation:

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

Length equation:

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \qquad (2)$$

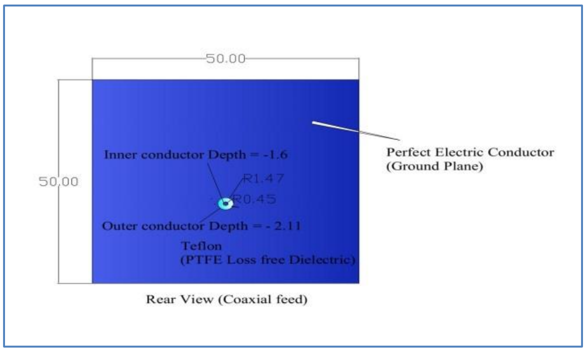

Figure 4. Rear View of Antenna

Frequency equation:

$$f_r = \frac{c}{2L\sqrt{\varepsilon_r + 1}} \qquad (3)$$

Coaxial feed line characteristic impedance:

$$Z_{0\infty} = {}^{60}\!/_{\sqrt{\varepsilon_r}}\, ln\, {}^{D_e}\!/_{d_e} = {}^{138}\!/_{\sqrt{\varepsilon_r}}\, log_{10}\, {}^{D_e}\!/_{d_e}\ \Omega \qquad (4)$$

III. RESULT AND DISCUSSION

Slotted dual-band circular patch antenna is simulated and designed in CST MWS and then fabricated. The Return loss is -31dB at 2.45 GHz and -23.7dB at 5.8 GHz as shown in the figure 5.

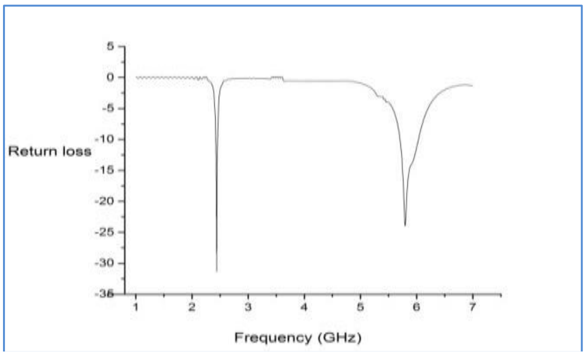

Figure 5. Return loss simulated result

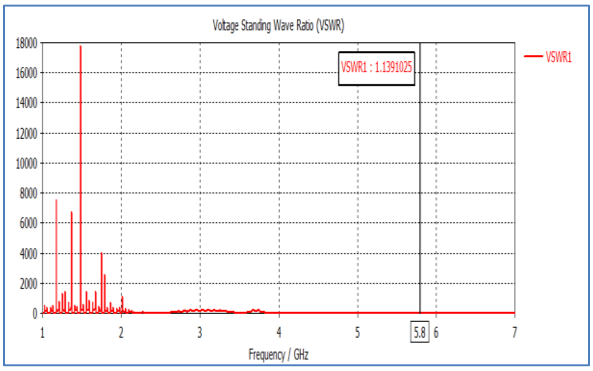

Figure 6. VSWR simulated antenna result

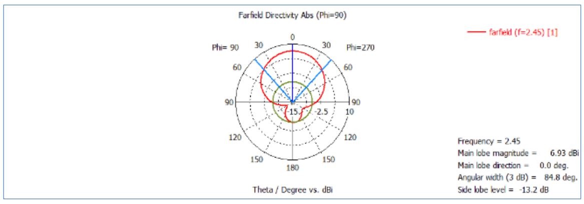

Figure 7. Radiation Pattern 2.45GHz

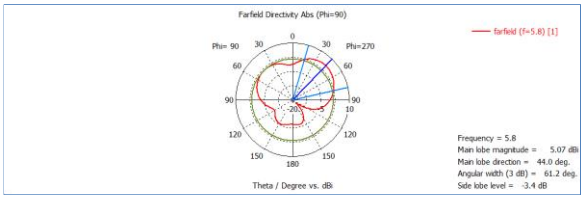

Figure 8. Radiation Pattern 5.8GHz

According to figure 6 The Voltage standing wave ratio of proposed antenna is 1.5 and 1.135 at 2.45GHz and 5.8GHz respectively. Radiation Pattern Plots of proposed antenna can be seen in figure 7 and 8 for frequency 2.45 and 5.8 GHz respectively.3-D gain patterns of simulated antenna can be seen in figure 9 and 10 for frequency 2.45 and 5.8 GHz respectively

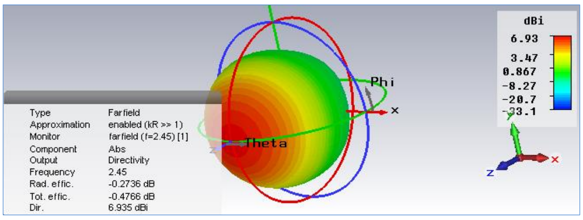

Figure 9. Radiation Pattern at 2.45GHz

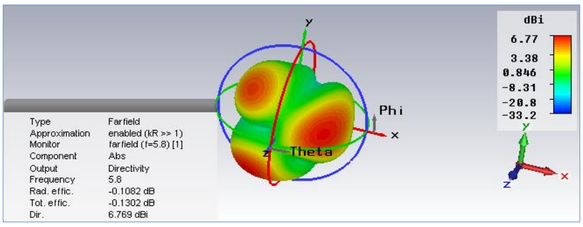

Figure 10. Radiation Pattern at 5.8GHz

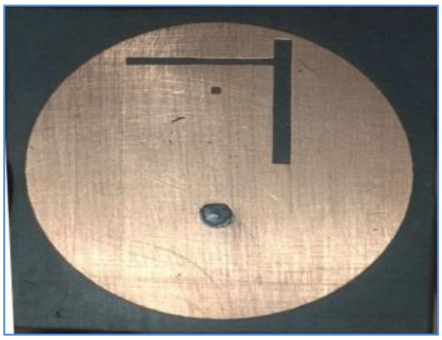

Figure 11. Front View

Figure 12. The Rear View

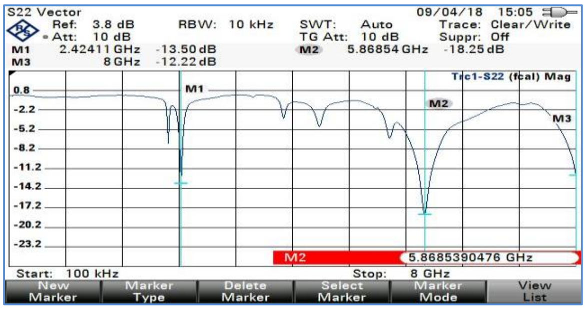

Figure 13. Return loss fabricated antenna result

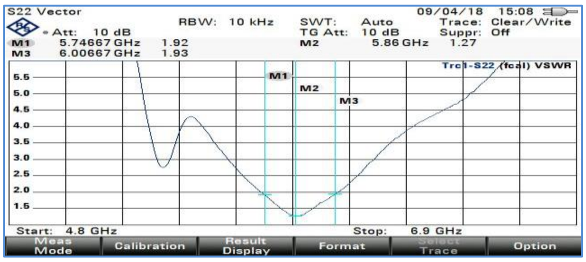

Figure 14. VSWR fabricated antenna result

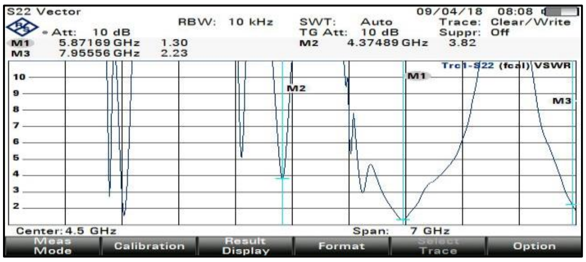

Figure 15. VSWR fabricated antenna result

The antenna is then fabricated and can be seen in figure 11 The front view and figure 12 The rear view. Return loss of fabricated antenna can be seen in figure 13. Fabricated antenna results of VSWR can be seen from the figure 14 and 15 at 5.8 GHz.It is quite evident from both the simulated and fabricated antenna results that the antenna has dual band characteristics with less than -10db (BW of 36MHz, gain of 6.661db, total efficiency of 89%) and (BW of 341MHz, gain of 6.661db, Total efficiency of 97%) for 2.4GHz and 5.8GHz respectively which is attained through famous slotting technique.

CONCLUSION

Numerous parameters of the antenna discussed and analyzed like radiation pattern, gain, return loss and finally analysis of VSWR both through simulation and fabricated results for design's complete understanding. The results shows that gain and bandwidth for both 2.45GHz and 5.8GHz is much high and it makes the antenna in heavy competition with those in the field for the different RFID applications

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