Design of Microstrip Patch Antenna for Active and Passive RFID Tags.

Aswathi P A, Sanish V S, Lincy K

Department of Electronics and Communication Engineering , Jawaharlal College of Engineering and Technology, Mangalam, Lakkidi, Ottapalam, Palakkad, Kerala, India.

***Abstract*— The microstrip patch antenna is a printable resonant antenna with distinguishing features such as integration, good radiation control and low cost of production. Thus it can use in a wireless linked application such as RFID. In this paper, the microstrip patch antenna is designed simulated for two frequencies of 5.6GHz and 5.8GHz using HFSS (High Frequency Structure Simulator) software which can be used for active and passive antenna.**

***Keywords*— Microstrip, RFID, HFSS.**

I. INTRODUCTION

The advancements in wireless technology given birth to radio frequency identification (RFID), which creates a significant interest among the scientists, researchers and industry. RFID technology can be used for identification, location and transferring of information using radio waves. It also reaches its application in areas of logistics, manufacturing, transportation, health care and mobile communication. Basically the RFID system consists of tag or a transponder and a transceiver or reader. The tag is combined with the application of integrated circuit chip (ASIC) which is activate and detect the tag. The transceiver or a reader transmits a modulated signal with periods of unmodulated carrier.

The microstrip patch antenna falls into the categories of printed dipole, slots and tapered slots on the basis of distinguished features including ease of integration, good radiation control and low cost production. Due to the antennas resonant style radiator so one of the dimension is $\lambda/2$ where λ is the guided wavelength of surrounding environment of printed antenna. The shape of the patch antenna is one of the factors of resonant dimensions. The dielectric constant ε_r of the substrate and its height depends on the antenna performance. One of the major advantages of the patch antenna is its size is relatively small comparator to other radiators. The minimal thickness of the substrate of the microstrip patch antenna make it easily integrated into the skins of the various objects.

Due to significant performance and cost advantages due to its light weight, low fabrication cost, and the ability to fabricate feed lines and matching networks simultaneously with the antenna structure, integrating microstrip patch antenna with RFID can achieve.

The patch antennas have narrow bandwidth which is its one of the major disadvantages, but RFID do not need much bandwidth, which turns its advantages.

There are two types of RFID system are there passive and active RFID system. Passive RFID systems are the tag get power through the transfer of power from a reader to the tag antenna. These types have short range transmission. In the case of active RFID systems the tag has its own power source like any external power supply unit or a battery.

II. DESIGN APPROACH

A. Selection of dielectric

For the air, polystyrene, honey comb the dielectric constant ranges 0 to 2. In the case of fibred glass reinforced Teflon it ranges from 2 to 4. And in the case of ceramic, quartz, alumina is in the range 4 to 10. The value of dielectric constant ε_r should be less than 4. Here we are using FR4 epoxy type dielectric which has value of 4.4.

B. Width of the Patch

The width of the patch is the important parameter want to consider for designing an antenna. It can be determined by using the equation:

$$W_p = \frac{c}{2f_r}\left((\varepsilon_r + 1)/2\right)^{-1/2}$$

where, f_r is the operating frequency and ε_r = 4.4.

C. Length of the Patch

The length of the patch is another important parameter that wants to consider for designing an antenna. It can be determined by using the equation:

$$L_p = \frac{c}{2f_r\sqrt{\varepsilon_e}} - 2\Delta L$$

where, ε_e is the effective dielectric constant.

The length and width of the patch is depends on the operating frequency.

D. Ground Floor

In practical design, the width and the length of the ground floor should be small as possible to reduce the size of the antenna. The length and width of the ground can be determined by using the equation given below.

$$L_g = L + 0.2\lambda_g$$

$$W_g = L + 0.2\lambda_g$$

where, $\lambda_g = \lambda_0 / \sqrt{\varepsilon_e}$, λ_0 represents the wavelength in the air. The size of the ground floor is also important factor for achieve a required parameter of the microstrip patch antenna. It also effects the operating frequency and return loss of the microstrip patch antenna.

E. Feeding Techniques

There are various feeding methods are used to feed the microstrip patch antenna. The most four feeding techniques used are microstrip line, coaxial probe, aperture coupling and proximity coupling. Because of the wide range of advantages such as more spurious feed radiation, better reliability, ease of fabrication and better impedance matchingmost commonly used feeding technique is microstrip line feed.

F. Designing Parameters

The parameters of rectangular microstrip patch antenna (RMSA) are calculated using the above equations are represented in the below table. In the case of passive antenna the frequency is 5.6GHz and in the case of active antenna the frequency is 5.8GHz.

TABLE I

PARAMETERS OF 5.8 GHZ MICROSTRIP ANTENNAS

Parameters	Values
Substrate Material	FR4 Epoxy
Relative permittivity of the substrate	4.4
Thickness of the dielectric	1.6mm
Operating Frequency	5.8GHz
Length of the patch	11.75mm
Width of the Patch	10.625mm
Length of the Feed	4mm
Width of the Feed	0.875mm
Air Box Material	Vacuum
Air Box Material	100*100*100mm
Port Type	Lumped Port

TABLE 2

PARAMETERS OF 5.6GHZ MICROSTRIP PATCH ANTENNA

Parameters	Values
Substrate material	FR4 Epoxy
Relative permittivity of the substrate	4.4
Thickness of the dielectric	1.6mm
Operating frequency	5.6GHz
Length of the patch	11.75mm
Width of the patch	10.625mm
Length of the feed	7.803mm
Width of the feed	0.5mm
Air box material	Vacuum
Air box dimension	100*100*100mm
Port type	Lumped

G. Simulation Results of Passive RFID Antenna

The microstrip patch antenna of rectangular shape is chosen. The midpoint of the patch is positioned with feed line. The antenna is simulated by using AnsoftHFSS. The microstrip antenna consists of three layers. The first one is the radiating plate (patch) which is of the dimension 11.75*10.625mm. The second one is the microstrip feed line with length 4mm and width of 0.875mm. The third layer is the substrate.

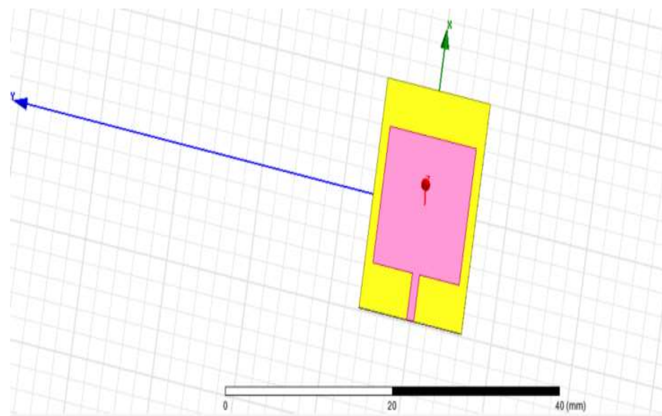

Fig 1 Rectangular 5.8GHz microstrip patch antenna

The substrate size is of 19.75*12.625mm and height of 1.6mm. The feed of dimension 4*0.875mm and the air box is of 100*100*100mm and the port used is lumped port. After simulation of the antenna optometric are performed to achieve the required parameters of the antenna.

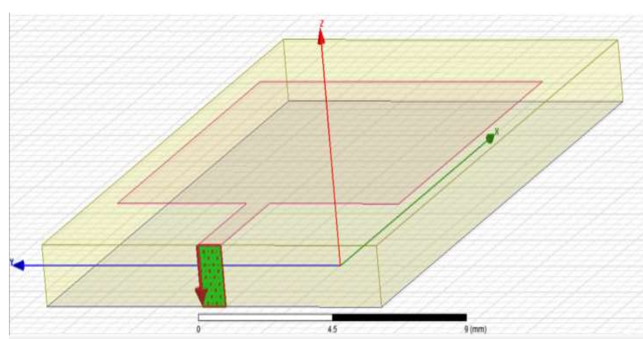

Fig 2 Lumped port excitation

The antenna dimension is to vary to meet the design specification. The simulation of patch antenna of given dimension give a promising result of s11= -34.997dB. The return loss depends on the feed line. The gain of the simulated antenna in HFSS is 4.885dB.

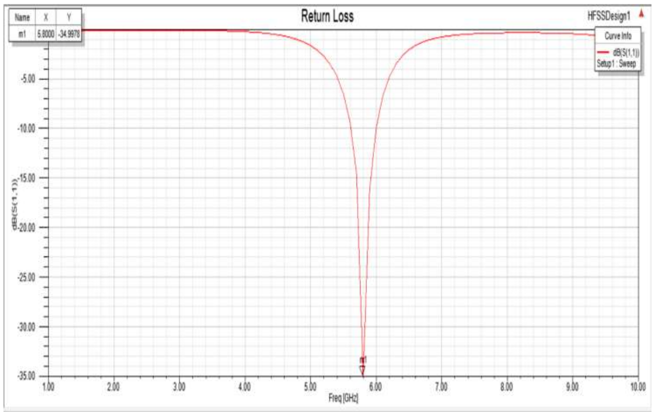

Fig 3 HFSS simulated return loss for 5.8GHz RFID application.

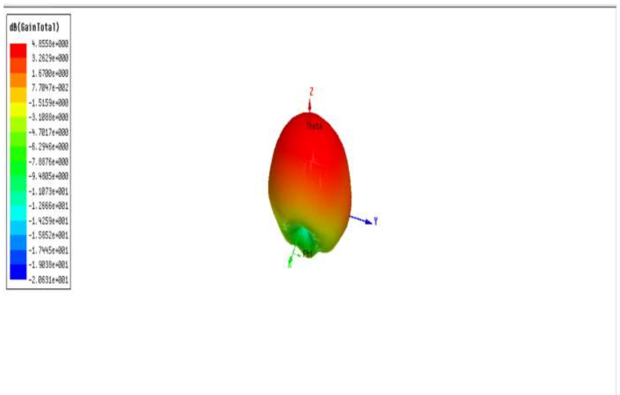

Fig 4 Far field radiation pattern over an infinite sphere with gain 4.88dB.

The analyzing parameters in the simulation result are VSWR (Voltage Standing Wave Ratio). The Voltage Standing Wave Ratio (VSWR) is the amount of mismatch between an antenna and the feed line connecting to it. The value of VSWR varies from 1 to infinity. The value of VSWR less than 2 is suitable for most of the application. In this design the simulated antenna showing the VSWR of 0.309dB.

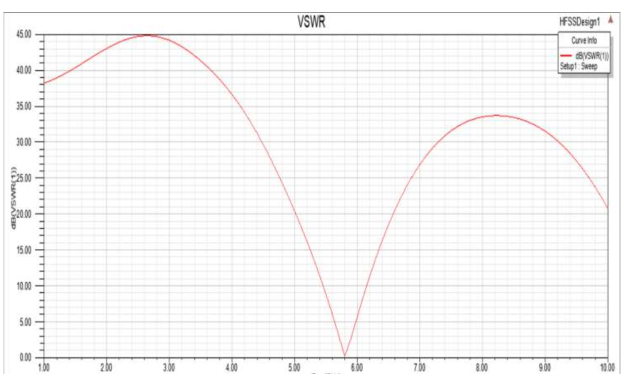

Fig 5 VSWR of simulated antenna

The next parameters that are consider for the analysis is radiation pattern. It is defined as the variation of the power radiated by antenna as function of the direction away from the antenna.

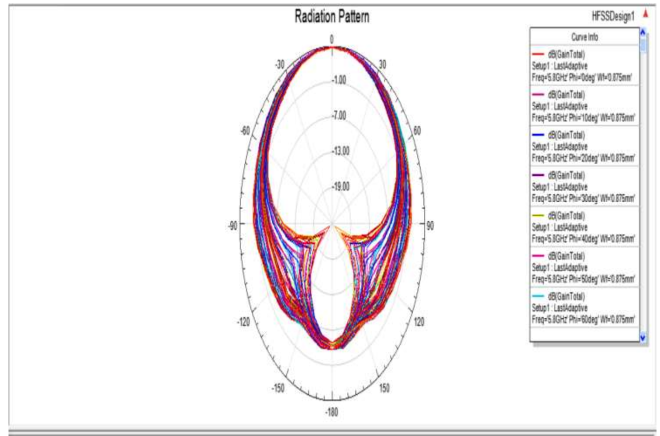

Fig 5 Final optimised microstrip patch antenna gain of 5.8GHz

H. *Simulation Results of Active RFID Antenna*

In the case of active RFID antenna the operating frequency that we used is 5.6GHz. With the reference to the information in the table the antenna is simulated and the corresponding results are analyzed.

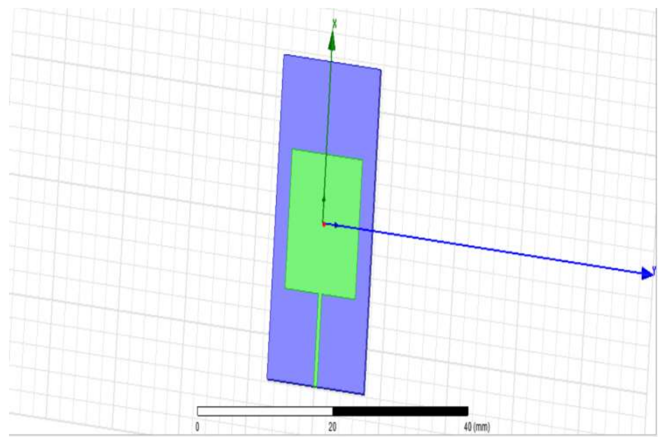

Fig 6 Rectangular 5.8GHz microstrip patch antenna

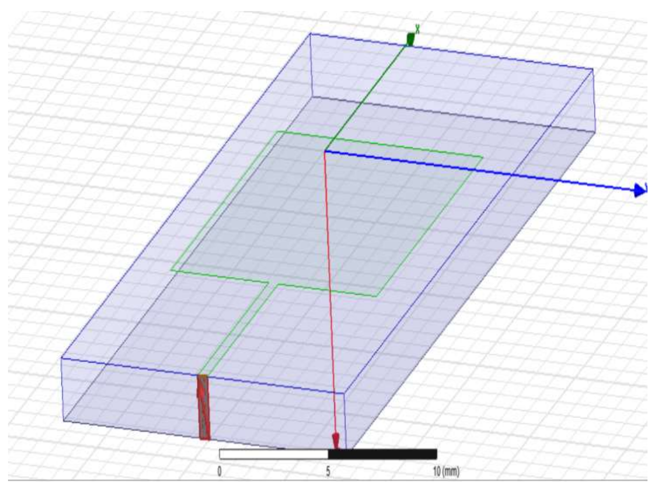

Fig 7 Lumped port excitation

In the case of return loss it found that it get reduced to -16.145dB.

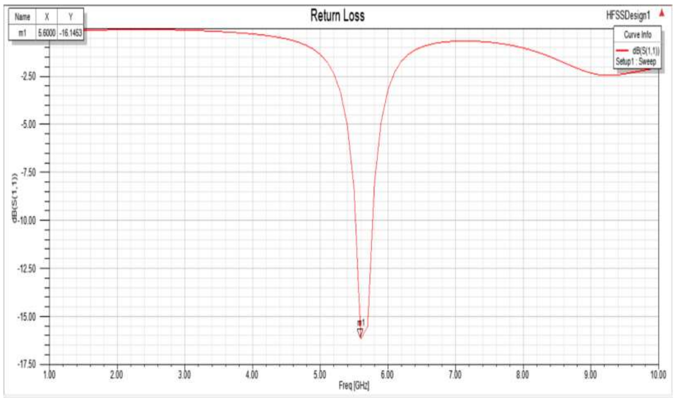

Fig 8HFSS simulated return loss for 5.6GHz RFID antenna

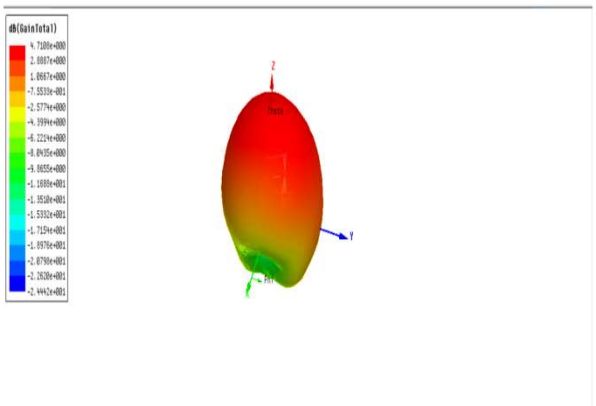

Fig 9 Far field radiation pattern over an infinite sphere with gain 4.71dB.

When the passive antenna's VSWR is compared with the active antenna's VSWR it was found that active antennas have larger VSWR compared to passive antenna. The active antennas have a VSWR of 2.7dB. It is a one of the disadvantages of this project.

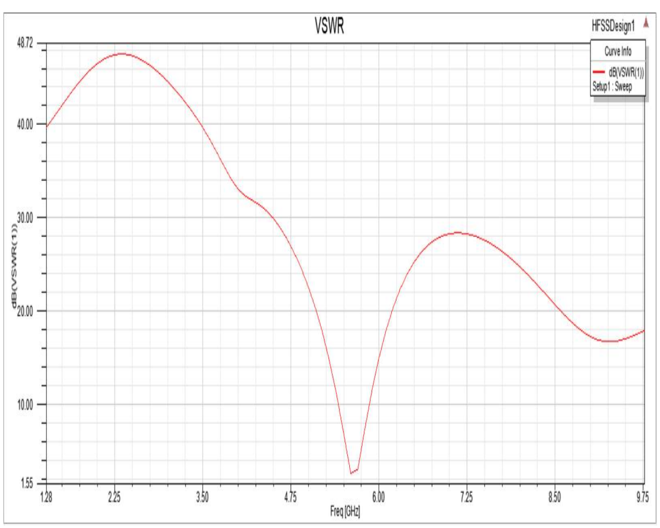

Fig 10 VSWR of simulated antenna

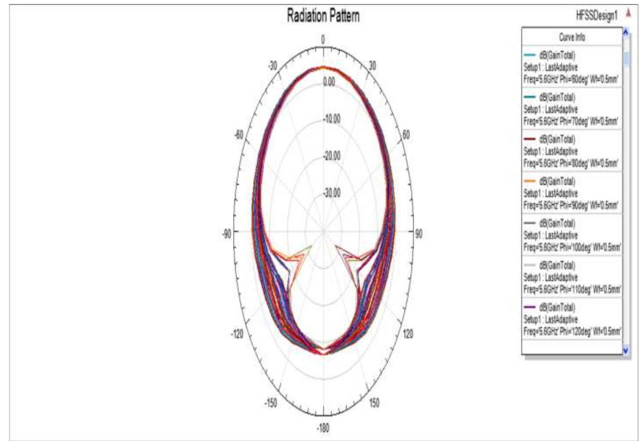

Fig 11 Final optimised microstrip patch antenna gain of 5.6GHz

III. CONCLUSION

An active and passive antenna for RFID applications are modeled and simulated using 3D HFSS. The passive patch antenna gain is optimized to be 4.71dB and active antenna with 4.88dB. And the return loss for passive is of -34.99dB and that of active is -16.145dB. All other parameters are optimized, analyzed and compared between active and passive RFID microstrip patch antenna.

ACKNOWLEDGMENT

This project was supported by my guide Ms. Lincy K, Assistant Professor, Department of ECE and Mr. Sanish S, Assistant Professor, Department of ECE in Jawharlal College of Engineering and Technology.

REFERENCES

[1]. Raied A. R. Ibrahim1, Mustapha C.E. Yagoub and Riadh W. Y. Habash (2009), IEEE- 978-1-4244-3508-1, Microstrip patch antenna for RFID applications.

[2]. M. D. ShamimShahriarHossain, and NemaiKarmakar (2006), 4th International Conference on Electrical and Computer Engineering, ICECE 2006, An Overview on RFID Frequency Regulations and Antennas.

[3]. H. Stockman, Proceedings of the IRE, pp. 1196-1204, October 1948. Communication by means of reflected power.

[4]. IBM, "IBM WebSphere RFID Handbook: A Solution Guide",(Online),Available:http://www.redbooks.ibm.com/abstracts/sg247 147.html. [Accessed: May 24, 2006].

[5]. BudakErhan, CatayBulent, Tekin Ibrahim; RFID Eurasia, 2007 1st Annual5-6 Sept. 2007 Page(s):1–3, IEEE CNF 2007, Microstrip Patch Antenna for RFID Applications.

[6]. R.B.Waterhouse, Kluwer Academic Publishers, 2003, Microstrip Patch Antennas A Designer's Guide.

[7]. C. A. Balanis, John Wiley and Sons, New York, 1996, Antenna theory: analysis and design.

[8]. C. E. Heinrich, RFID and beyond growing your business through real world awareness. Indianapolis, IN: Wiley Pub., 2005.

[9]. M. Philipose, J. R. Smith, B. Jiang, A. Mamishev, S. Roy, and K. Sundara-Rajan, Battery-free wireless identification and sensing, Pervasive Computing, IEEE, vol. 4, pp. 37-45,2005.

[10]. S. Lahiri, RFID sourcebook. Upper Saddle River, NJ: IBM Press, 2006.