Inset Fed Rectangular Microstrip Patch Antenna for UHF Radio Frequency Identification

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***Abstract*— In this paper a 0.92 GHz inset line fed rectangular microstrip patch antenna has been designed for UHF RFID application with return loss more than -32db, bandwidth 2.71 % and VSWR 1.0473. Design and simulation of this antenna has been done on HFSS software.**

***Keywords* —UHF RFID, Inset-Feed Line, Rectangular Microstrip Antenna, VSWR, Return loss, HFSS.**

I. INTRODUCTION

Microstrp patch antenna is a type of antenna that offers a low profile, i.e. thin and easy manufacturing ability, which provides great advantages over traditional antennas [1]. Some of the disadvantages of microstrip antenna configurations includes narrow bandwidth, however this disadvantage turn out to be advantage for UHF RFID reader as RFID application do not need much bandwidth because antenna rejects the signals that are out of the band and accordingly increases the quality factor. [2] These antennas can be placed on land or space vehicles, easy to networks for tens or hundreds element, connected directly to the power supply device that goes in the direction of integrating the antenna and power supply. [3] [4]

Radio Frequency Identification (RFID) is a technology to transmit the identity of an object or person at a distance without a direct line of sight using radio waves. Now days RFID is widely used in logistics management, inventory control, service industries, and goods flow systems etc. Recently there have been many studies on RFID antenna mostly on Ultra High Frequency, UHF band [8] and even on dual band antenna. [6] [7] RFID system demands low profile, low cost and easily fabricated antenna. So microstrip patch antenna offers a potential solution and therefore it is a popular printed resonant narrow band antenna for this application. [5] [10]

II. ANTENNA DESIGN PRINCIPLE

In the most basic form, patch antenna consist of radiating element and a ground plane separated by a dielectric substrate. In this work we have used transmission line modal. All the dimensions of the antenna are calculated based on equations (1)-(5) [9] [11]. The length is given by

$$L = 0.49\frac{\lambda}{\sqrt{\varepsilon_r}} \quad (1)$$

The width is given by

$$W = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (2)$$

Where, f_r is the resonant frequency of the patch antenna, C is the free space velocity of light. The effective dielectric constant for the space of $(W/h)>1)$ [12] is given by

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1+12h/W]^{-1/2} \quad (3)$$

The extension of patch length due to fringing effect can be determined by

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\,(\frac{W}{h}+0.26)}{(\varepsilon_{eff}-0.258)\,(\frac{W}{h}+0.8)} \quad (4)$$

The effective length of patch after taking into fringing effect can be calculated by

$$L = \frac{C}{2f_o\sqrt{\varepsilon_{eff}}} - 2\Delta L \quad (5)$$

III. PROPOSED ANTENNA DESIGN

Fig. 1 shows the proposed inset fed line rectangular microstrip patch antenna constructed on substrate layer of material Rogger TMM4 (tm) having relative permittivity (ε_r) = 4.5 and thickness (h) = 1.5mm with Tangent (tanδ) = 0.002.

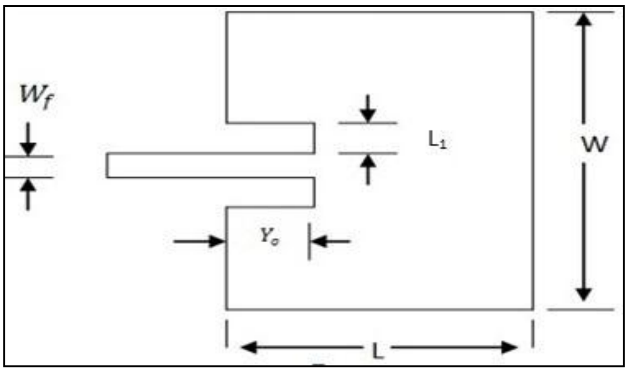

Fig.1. Geometry of the proposed antenna

IV. EXPERIMENTAL RESULTS

Antenna resonant frequency (f_r) is 0.92GHz which was intended for UHF RFID applications. As shown in Fig. 2, the length (L) of patch antenna is 77 mm and its width (W) is 98 mm. The inset feed line (Y_o) is 7 mm, with feed line width (W_f) of 1 mm and inset gap (L_1) is 3 mm. The patch antenna and the power line are engraved on the same substrate.

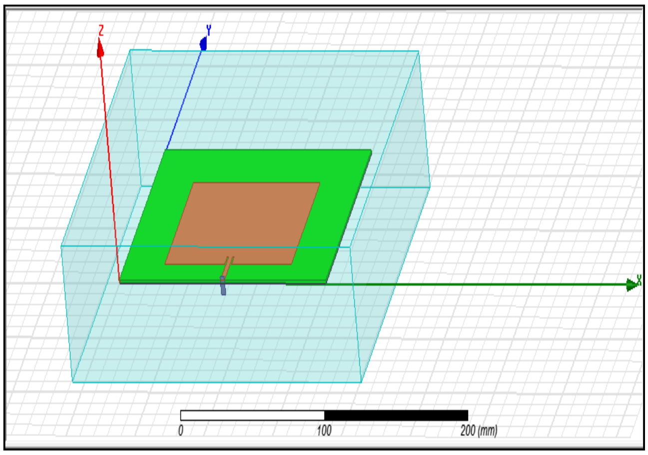

Fig. 2. HFSS design model of proposed antenna

After the laborious iteration work of antenna dimensions, such as length (L), width (W) and inset feed line (Y_o) -26 dB return loss is achieved as shown in table 1 and Fig. 3.

TABLE I. RETURN LOSS VALUES AGAINST THE INSET GAP

Inset Gap (L_1)	Return loss
1mm	-11.9264 db
4mm	-7.9610 db
7mm	-25.8950 db
8mm	-14.2506 db
9mm	-3.0481 db

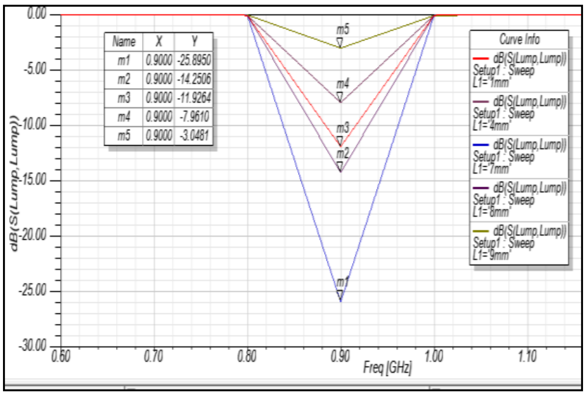

Fig. 3. Inset gap plot against return loss

As by changing the dimensions of proposed patch antenna, resonant frequency can be controlled. The Fig. 4 shows return loss as the function of frequency. Here we see that reflection coefficient (S_{11}) is more than -32db. Which implies that antenna is well suitable with bandwidth of 2.71%.

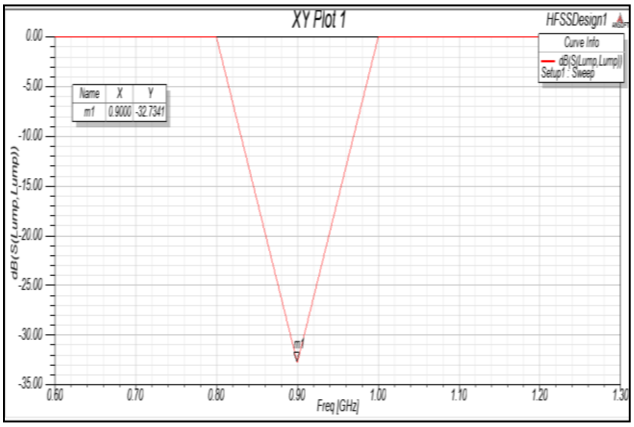

Fig. 4. Return loss in db

The standing wave ratio (VSWR) is shown in Fig. 5 depending on the frequency. The result and order of VSWR 1.0473 is shows high suitability.

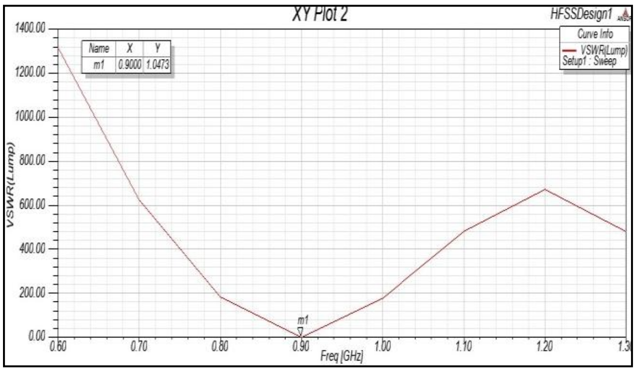

Fig. 5. Standing Wave Ratio

Table II summaries the result obtained in our work. Fig. 6 and Fig. 7 shows radiation pattern and 3D polar plot of antenna proposed.

TABLE II. RESULTS OF DESIGNED ANTENNA

Parameter	Value
S_{11} (db)	-32.73
Z_{in} (Ω)	51.212
VSWR	1.0473
Bandwidth (%)	2.71

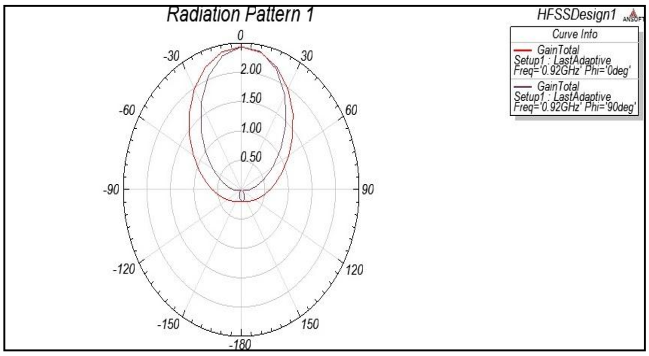

Fig. 6. Radiation pattern of proposed antenna

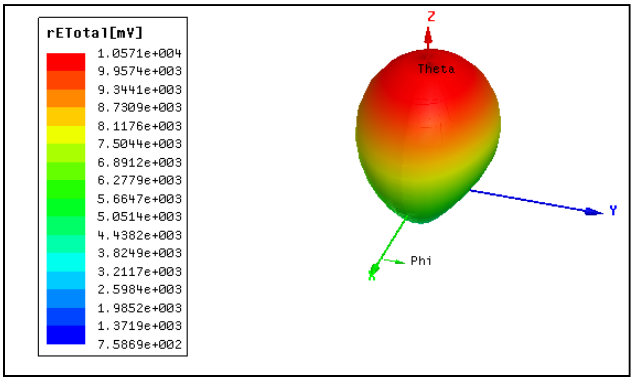

Fig. 7. 3D Polar plot of designed antenna

V. CONCLUSION

From the simulation analysis of proposed antenna it can be easily observed that the designed inset fed rectangular microstrip patch antenna is a suitable option for UHF RFID application with its numerous advantages over the other antenna, it is light weight, inexpensive and easy to integrate with accompanying electronics. Detail knowledge of antenna parameters and HFSS software is required to design and simulate desired results. Here return loss of -32.73 db and VSWR 1.0473 with 2.71% bandwidth is achieved by estimated variation of antenna dimensions.

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