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A Microstrip Antenna Design and Performance Analysis for RFID High Bit Rate Applications

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Abstract—Lately, an interest has grown greatly in the usages of RFID in an un-presidential applications. It is shown in the adaptation of major software companies such as Microsoft, IBM, and Oracle the RFID capabilities in their major software products. For example Microsoft SharePoints 2010 workflow is now fully compatible with RFID platform. In addition, Microsoft BizTalk server is also capable of all RFID sensors data acquisition. This will lead to applications that required high bit rate, long range and a multimedia content in nature. Higher frequencies of operation have been designated for RFID tags, among them are the 2.45 and 5.8 GHz. The higher the frequency means higher range, and higher bit rate, but the drawback is the greater cost. In this paper we present a single layer, low profile patch antenna operates at 5.8 GHz with pure resistive input impedance of 50 and close to directive radiation. Also, we propose a modification to the design in order to improve the operation band width from 8.7 to 13.8

Keywords—Microstrip Antenna, RFID, U-shaped, double layer, circular antenna.

I. Introduction

RADIO frequency identification (RFID) is becoming more popular in many modern applications, it is considered one of the most active commercial research fields. RFID system consists mostly of three main components - A RFID transponder, a RFID reader and antenna. Figure. 2 shows the block diagram of RFID system. There are several bands assigned to RFID applications, these bands are 125 KHz, 13.56 MHz, 866 - 869 MHz, 902 928 MHz, 2.45 GHz (2.400 - 2.4835 GHz) and 5.8 GHz (5.725 - 5.875 GHz). These bands can be split into two categories: low frequencies with the advantage of low cost but with short reading ranges and low bit rate while the second category is the high frequencies that have higher range with high data transfer rate, but the drawback of greater costs. The reader antenna design becomes more acute and critical in the microwave region, Microstrip antenna is very good choice and that for their well-known advantages of low profile, light weight, conformal to carrier and easy production.[1-5]

II. PROPOSED ANTENNA DESIGNS

In this section we propose three different designs of microstrip antennas. Geometry of these antennas and details of there profiles are shown in figures 2, 3 and 4.

Based on some of the parameters given in [6] and the method used in [7], figure 2 shows the first proposed design for the RFID applications. It consists of one layer with FR4

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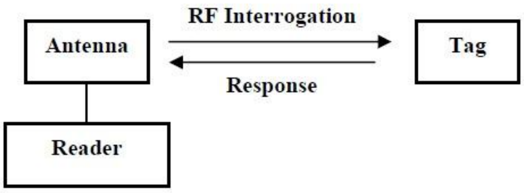

Fig. 1. Simulation Results

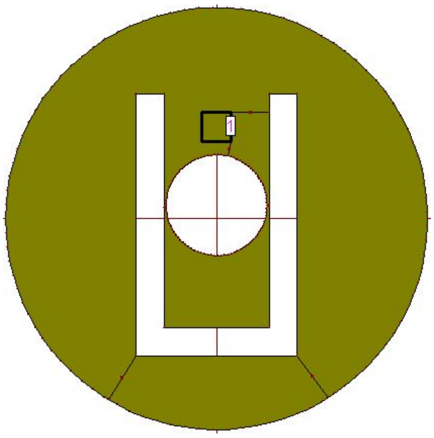

Fig. 2. Geometry of Antenna design 1

dielectric constant (4.4). This profile has a large circle with a hole and a U-shaped inside it. The outer radius is 15.7 mm and the hole is 3.75 mm shifted up by 1 mm from the center. The U-shaped has W = 19.5 mm , L = 12 mm, and t = 2.1 mm . The thickness of the substrate is 2 mm. While the Probe-Feed is posted 7 mm from the center.

Depending on the method used in [8] figure 3 shows the second proposed antenna and as it appears it has two layer with different dielectric materials. The first layer is shaped as a ring with outer radius of 21 mm and inner radius of 6.9 mm. The dielectric constant of the first layer is 2.55 and thickness h of 1.5 mm. The second layer is also a ring with outer radius of 14.95 mm and inner radius of 12.95 mm, while the thickness is 0.45 mm with dielectric constant of 2.55.

Finally, the third antenna, as shown in figure 4 consist of two layers. The first layer is shaped as a ring with outer and inner radii equal to 21 mm and 6.9 mm, respectively. The thickness of this layer is 1.5 mm with 2.55 dielectric constant. The second layer is a small circle above the first layer by 0.75 mm in the middle with radius of 2.5 mm and dielectric

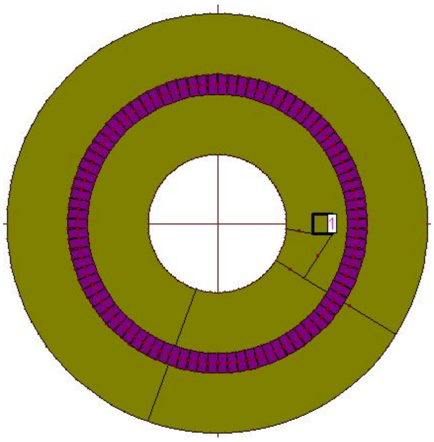

Fig. 3. Geometry of Antenna design 2

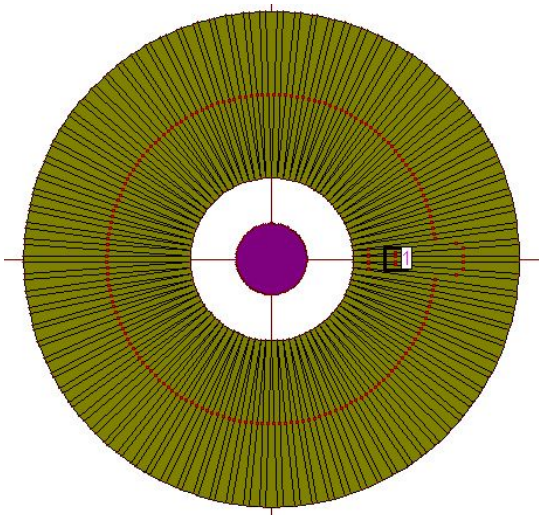

Fig. 4. Geometry of Antenna design 3

constant of 2.2.

III. SIMULATION AND RESULTS

Extensive simulations have been conducted using the Zeland IE3D EM software package. Simulation results are shown in figures 5-13 for all geometries. For each geometry we present the following characteristics: return loss, input impedance, and radiation pattern.

The return loss for the first geometry is shown in figure 5. It is clear that the resonant frequency is at 5.8 GHz with narrow bandwidth about 0.8 %. The input impedance is pure resistive and equal to 50 Ω with directive radiation pattern as shown in figures 6 and 7.

The second geometry makes a good improvement of 8.7% which is presented in figure 8. While the radiation pattern remain almost the same. The input impedance is still pure resistive and close to 50Ω.

Finally, the third geometry has the most improvement in the bandwidth with a 13.8% of the resonance frequency. The

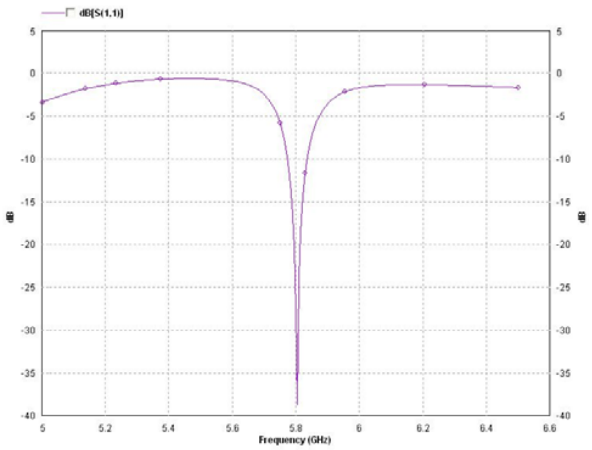

Fig. 5. Return loss for geometry 1

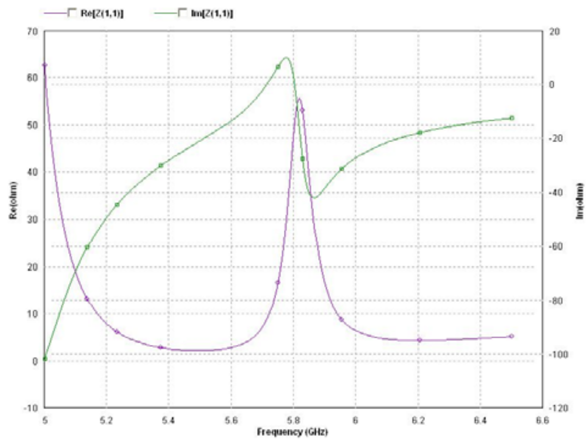

Fig. 6. Zin for geometry 1

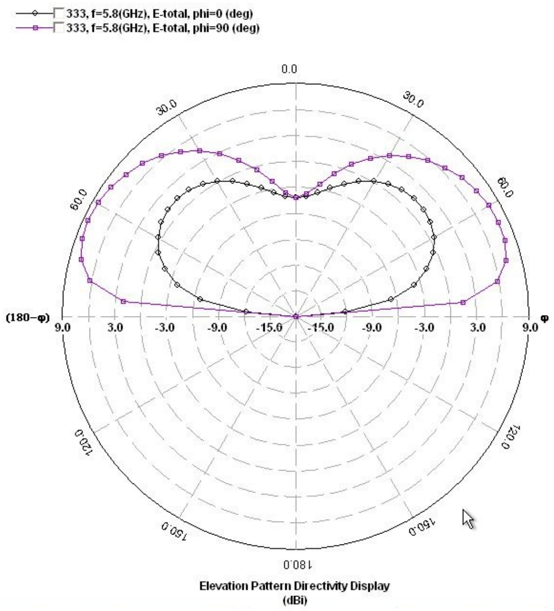

Fig. 7. Radiation pattern for geometry 1

TABLE I
RESULTS SUMMARY

Parameter	Geometry 1	Geometry 2	Geometry 3
Lower frequency (GHz)	5.769 GHz	5.752 GHz	5.732 GHz
Higher frequency (GHz)	5.83 GHz	6.259 GHz	6.532 GHz
Center frequency (GHz)	5.799 GHz	5.802 GHz	5.792 GHz
% BW (- 10db)	0.8	8.7	13.8
Return loss (db)	-36.66	-34.67	-19
Impedance (Ω)	50.47	47.058	40.34

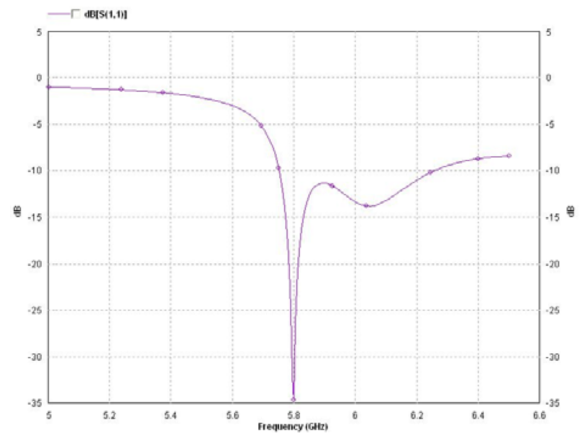

Fig. 8. Return loss for geometry 2

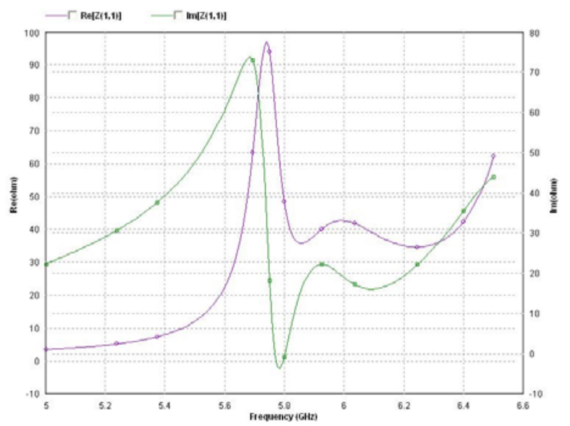

Fig. 9. Zin for geometry 2

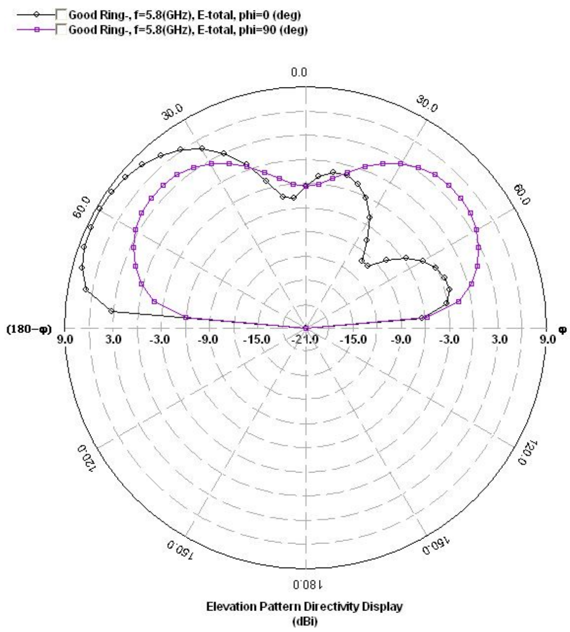

Fig. 10. Radiation pattern for geometry 2

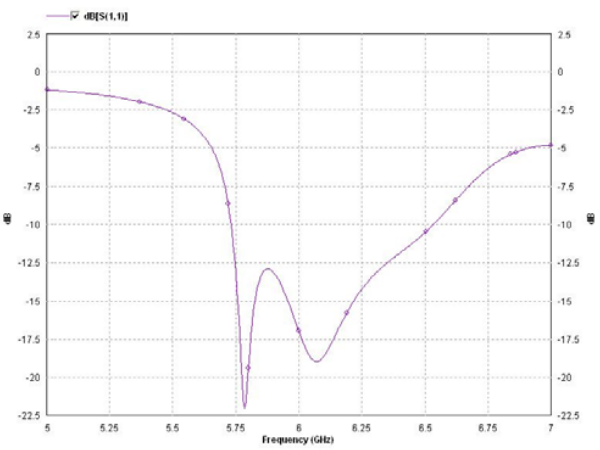

Fig. 11. Return loss for geometry 3

radiation pattern experiences a degradation in its directivity while the input impedance is still the same as shown in figures 11, 12, and 13. Table 1. summarizes all obtained results.

IV. CONCLUSION

In this paper three different geometries of microstrip antennas for RFID 5.8 GHz multimedia application have been introduced and analyzed. Simulation results have shown a bandwidth of 13.8% at the operation frequency of 5.8 GHz with matching input impedance of 50 Ω and a radiation pattern suitable in many inventory applications and customer advertisements.

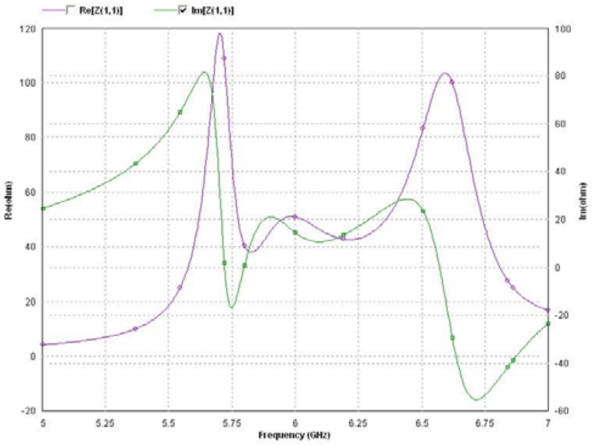

Fig. 12. Zin for geometry 3

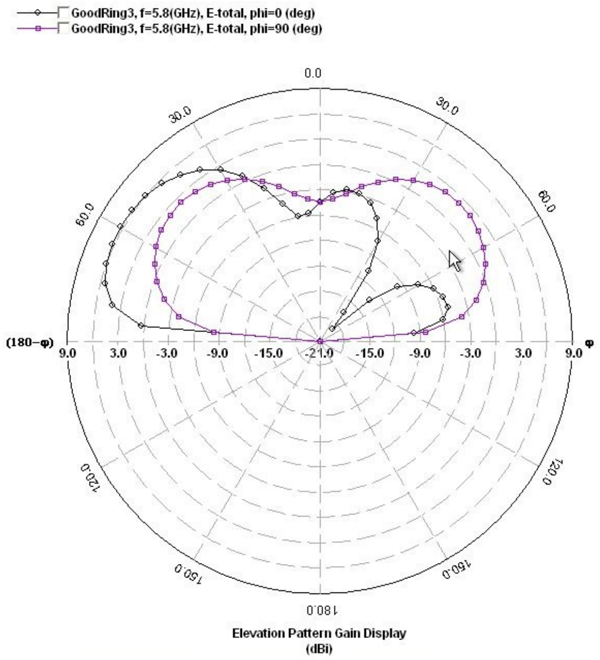

Fig. 13. Radiation pattern for geometry 3

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