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Designing an UHF RFID Reader Antenna

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Abstract

In this paper, a circularly polarized (CP) Octagonal shape microstrip patch antenna fed by coaxial feed is designed and analyzed for RFID (Radio Frequency Identification) reader applications. The physical parameters of the structure as well as its partial ground plane are analyzed and optimized using Zealand IE3D simulation software. Return loss (S11), voltage standing wave ratio (VSWR), directivity and gain are carried out. The results show that the proposed antenna has good impedance and radiation characteristics over the required bandwidth, 860-960 MHz (UHF RFID band). The return loss of the optimized Octagonal-shaped microstrip patch antenna is below 10dB over the UHF frequency band. The proposed antenna is very promising for various modern communication applications.

Keywords: Octagonal-shaped,microstrip patch antenna, Zealand IE3D Simulation Software, return loss (S11), voltage standing wave ratio (VSWR).

1. Introduction

Radio frequency identification (RFID) is a technology that provides wireless identification and tracking capability and is more robust than a bar code. Now RFID finds many applications in various areas such as electronic toll collection, asset identification, retail item management, access control, animal tracking, and vehicle security [1]. A reader (now more typically referred to as an RFID interrogator) is basically a radio frequency (RF) transmitter and receiver, controlled by a microprocessor or digital signal processor. An RFID reader emits electromagnetic signals where an RFID tag draws power from it. This power is then used to energize the microchip's circuits. The chip then modulates the waves and sends back this modulated wave to the reader. This process is called backscattering where the reader sees the tag [2]. In RFID system, the role of antennas (for reader and tag) is very important. The antenna allows the chip to transmit the information that is used for identification. The reader antenna should have circular polarization (CP) characteristic since the tag antenna can be arbitrary positioned on the target. The size reduction and gain enhancement of UHF RFID reader antenna have been key issues to the system developer [3].

In telecommunications, microstrip patch antenna is widely used because of their several advantages such as light weight, low volume, low fabrication cost and capability of dual or triple frequencies operations. However microstrip antenna suffers from numbers of disadvantages. Narrow bandwidth is a serious limitation of these microstrip patch antenna [4].

In this paper, a single band Octagonal-shaped microstrip patch antenna for RFID reader and wireless communications is designed to resonate on the Ultra High Frequency (UHF) RFID bands of 860MHz-960Mhz. The theoretical simulations are performed using IE3D simulation software.

2. Antenna Configuration

The front view of the design is shown in Fig.1

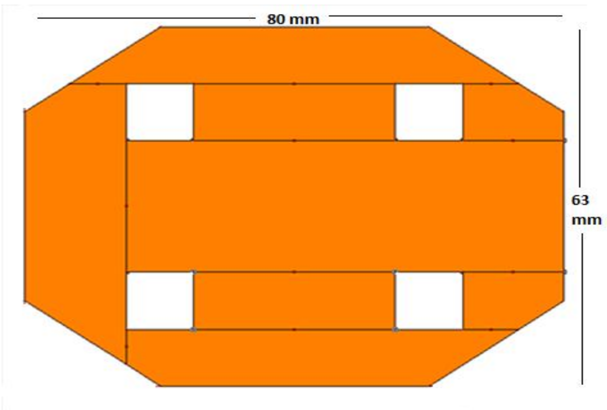

Fig. 1: Front view of the octagonal shaped microstrip patch antenna.

The design of Octagonal-shaped microstrip patch antenna consist of antenna width (W), antenna length (L) and a feed line which have impedance of 50 ohm. Dielectric substrate materials are used for design E-shaped microstrip patch antenna. A FR4 (loss-free) substrate was used while designing the antenna. The substrate used has thickness (h) of 1.6 mm, dielectric constant of 4.7 and loss tangent of 0.019..

There were equations used to calculate Length and Width.

Patch Width,

$$W = \frac{c}{2fo}\left[\frac{\varepsilon r+1}{2}\right]^{-1/2} \quad (1)$$

where;

fo =operating frequency

ε r=dielectric constant=4.7

c=speed of light =3x10^8 m/s

Effective dielectric constant,

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

Effective Length,

$$L_{eff} = \frac{c}{2fo[\varepsilon reff]^{1/2}} \quad (3)$$

Length Extension,

$$\Delta L = 0.412h\frac{(\varepsilon reff+0.3)(W/h+0.264)}{(\varepsilon reff+0.258)(W/h+0.8)} \quad (4)$$

where;

h=substrate thickness=1.6mm

Actual patch length,

$$L = Leff - 2\Delta L \quad (5)$$

After Calculations, values of Patch Length(L) and Patch Width(W) are as follows:

L=80mm

W=63mm

3. Results and Discussions

Return loss, VSWR ,Impedance and gain are simulated and presented in this paper:

4. Return Loss

We can see from the fig2, the simulated return loss is -27.3db at 0.93 GHz

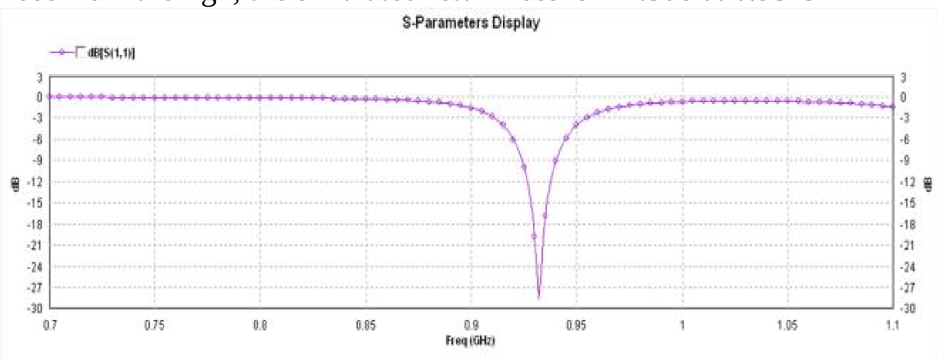

Fig. 2: Return loss(S11) Parameter Graph

5. Voltge Standing Wave Ratio(VSWR)

We can see from the fig3. VSWR is 1.1 at 0.93GHz.

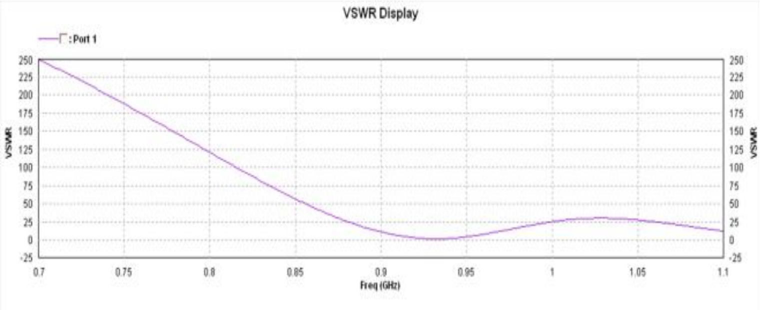

Fig. 3: Voltage Standing Wave Ratio Graph.

6. Impedance

We can see from the fig4.Impedance is 50Ω at 0.93GHz

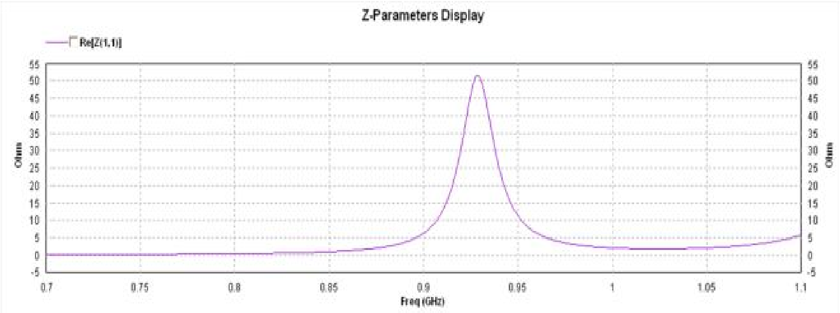

Fig. 4: Impedance Parameter Graph.

7. Polar Plot Graph for Gain

Fig. 5. below shows Polar Plot Graph for Gain. Gain is 6.10db

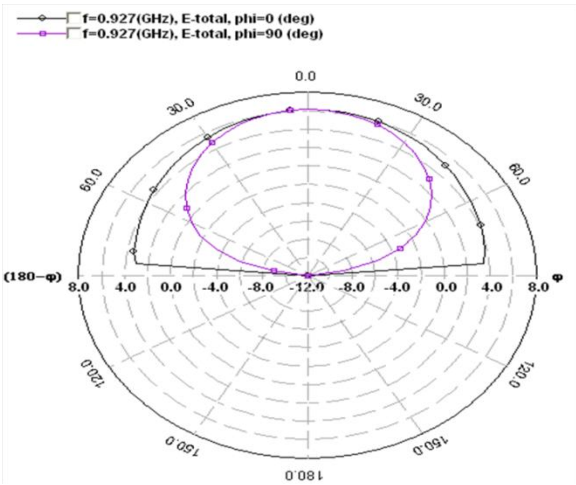

Fig. 5: Polar Plot Graph for Gain

8. 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 circularly polarized (CP) Octagonal-shaped microstrip single layer patch antenna been designed for UHF RFID reader. The return loss was below -10dB for 930 MHz. The antenna is thin and compact with the use of low dielectric constant substrate material. These features are very useful for worldwide portability of wireless communication equipment.

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