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Read Range Performance of UHF RFID Reader Antenna

Venkata Raviteja. K, K.S.N Murthy, I.Govardhani, M.Venkata Narayana

***Abstract:-** Now a days ultrahigh frequency (UHF) radio frequency identification has gaining popularity because of its rapid development in automated identification of objects wirelessly and having wide range of applications. Radio frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag called RFID tag or label attached to an object through a reader for the purpose of identifying and tracking the object. The tag's information is stored electronically. It includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. In this paper, the read range capabilities of proposed antenna at UHF range are determined. By using the proposed antenna we simulate return loss, gain, Vswr and radiation patterns using HFSS software.*

***Index Terms:** Radio frequency identification (RFID), Reader antenna, Ultrahigh frequency (UHF), Near-field, Far-field*

1. INTRODUCTION

Radio-frequency identification (RFID) [1] is the use of a wireless non-contact system that uses the radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. An RFID system [2] uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receiver which exists are called interrogators or readers send a signal to the tag and read its response. The RFID tag includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. Ultrahigh frequency (UHF) designates the ITU radio frequency range of electromagnetic waves ranging between 300 MHz and 3 GHz. The main advantage of UHF transmission is the physically short wave that is produced by the high frequency. The size of transmission and reception antennas is related to the size of the radio wave. The UHF antenna is stubby and short. Smaller and less conspicuous antennas can be used with higher frequency bands. Ultrahigh frequency (UHF) [3] radio frequency identification (RFID) is a rapidly growing technology for automated identification of objects wirelessly. Based on types of objects and applications, inductively coupled near-field [4] operation or electromagnetically coupled far-field [5] operation are used to transfer information between reader and tag. Far-field communication is widely used due to its long read range. Near-field reading can be useful for objects having metals and liquids in their vicinity because normal far-field tags' performance is affected by the presence of these objects. Here the segmented loop technique is employed to achieve near-field RFID at Ultrahigh frequency (UHF) range. A segmented loop antenna [6] is presented for ultra-high frequency (UHF) near-field radio frequency identification (RFID) applications. The proposed segmented configuration makes the current along the loop remain in-phase even though the perimeter of the loop is comparable to the operating wavelength, so that a strong and uniform magnetic field is generated in the region surrounding the antenna. A patch antenna is inserted in between the segmented loop in order to achieve far-field RFID along with near-field RFID design.

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II. ANTENNA MODEL

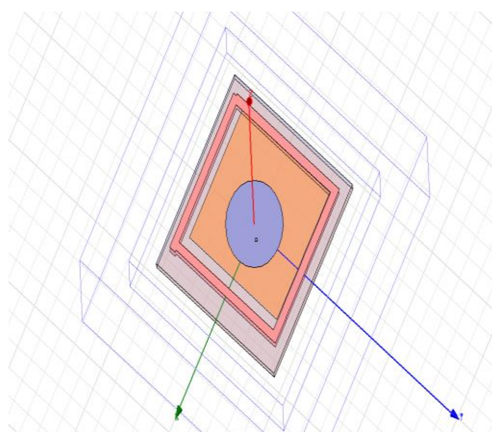

Fig1: Proposed Antenna Model.

III. ANTENNA DESIGN CONSIDERATIONS

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The proposed structure of the antenna is shown in Fig. (1).The antenna is simulated on an Rogers RT/duroid 5880 (tm) substrate with a dielectric constant of 2.2 and a loss tangent of 0.0009. The thickness of the substrate is 0.16cm. The size of the antenna is 15 x 15 x 0.8 cm, which is suitable for most RFID applications. Patch with circular at center top, rectangle at bottom is proposed for the frequency of L band application.

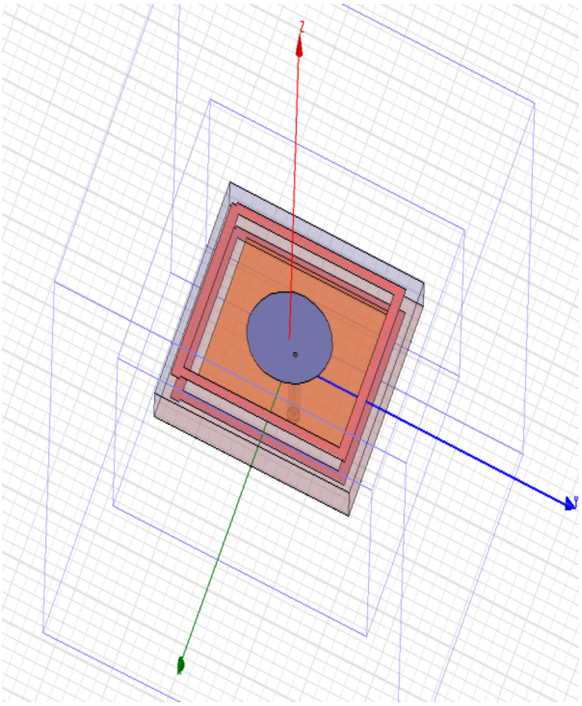

Fig. 2. Ansoft-HFSS generated antenna model

The patch can be fed with a probe through ground plane. The probe position can be inset for matching the patch impedance with the input impedance. This insetting minimizes probe radiation. The ease of insetting and low radiations is advantages of probe feeding as compared to microstrip line feeding. The dimensions of shaped patch shown in Fig. (1).The proposed antenna designed at operating frequency is 1.4915GHz.

IV. HFSS

HFSS is a high-performance full-wave electromagnetic(EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modeling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Resonant frequency, and Fields.

V. SIMULATION &ANALYSIS

A. Return loss:

It is a measure of the reflected energy from a transmitted signal. It is commonly expressed in positive dB's.The larger the value the less energy that is reflected.

The designed antenna is simulated using HFSS software. The results obtained are mentioned below,

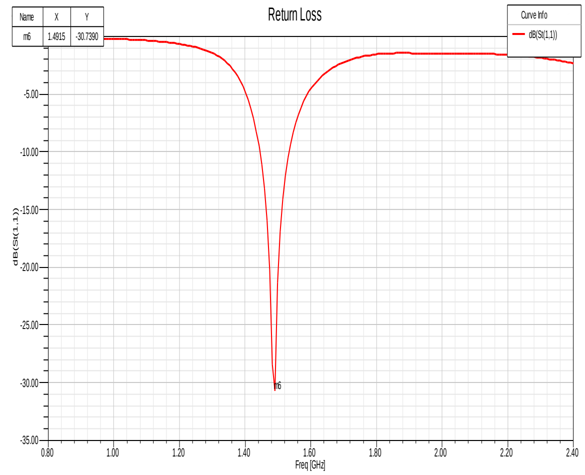

Fig3: Return loss.

A return loss of -30.7390 dB is obtained at 1.4915 GHz.

B. Gain

The ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically.

2-D Gain:

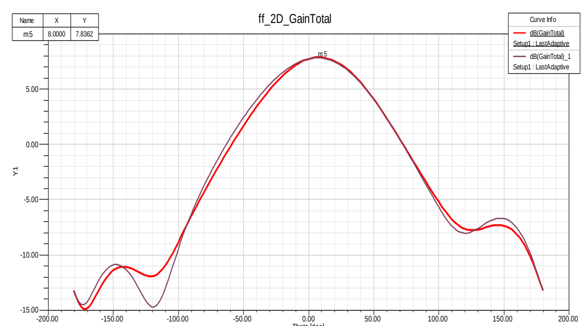

Fig4: 2-D Gain.

3-D Gain:

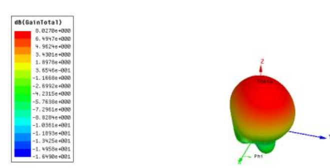

Fig5: 3-D Gain

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For the antenna model a 2D Gain of 7.8362dB and a 3D Gain of 8.0270 dB is obtained.

C. E-field pattern

An electric field can be visualized by drawing field lines, which indicate both magnitude and direction of the field. Field lines start on positive charge and end on negative charge. The direction of the field line at a point is the direction of the field at that point. The relative magnitude of the electric field is proportional to the density of the field lines.

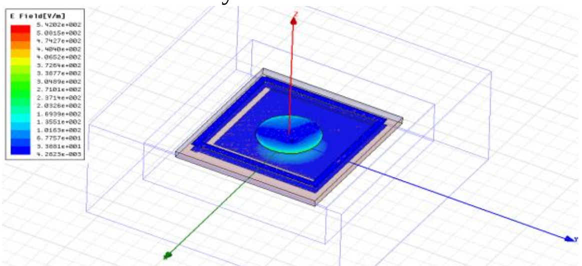

Fig6: E-Field pattern.

D. H-field Pattern

In the case of the same linearly polarized antenna, this is the plane containing the magnetic field vector and the direction of maximum radiation. The magnetic field or "H" plane lies at a right angle to the "E" plane. For a vertically-polarized antenna, the H-plane usually coincides with the horizontal/azimuth plane. For a horizontally-polarized antenna, the H-plane usually coincides with the vertical/elevation plane.

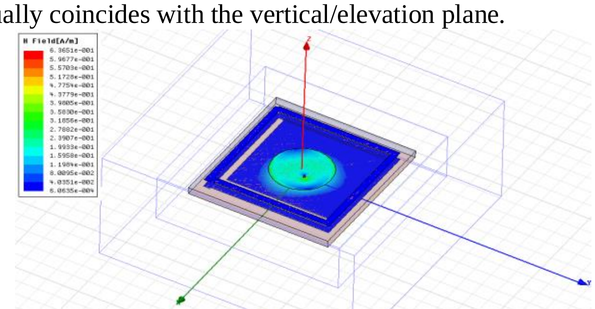

Fig7: H-Field pattern.

E. Vector E- Field:

The field equations of Einstein Cartan Evans (ECE) are used to develop the concept of the static electric field as a vector boson with spin indices −1, 0, +1, which occur in addition to the vector character of the electric field. The existence of the electric vector boson in physics is inferred directly from Cartan geometry, using the concept of a spinning space-time that defines the electromagnetic field. When the electromagnetic field is independent of the gravitational field the spin connection is dual to the tetrad, producing a set of equations with which to define the electric vector boson. Angular momentum theory is used to develop the basic concept.

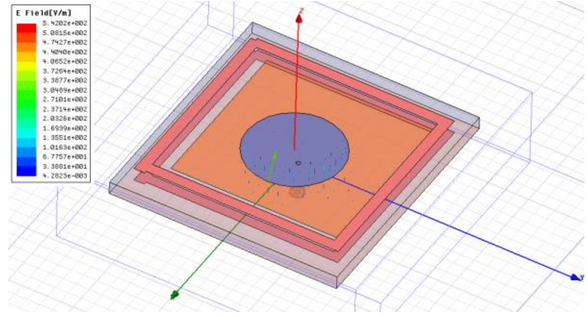

Fig8: Vector E-Field pattern.

Vector H- Field

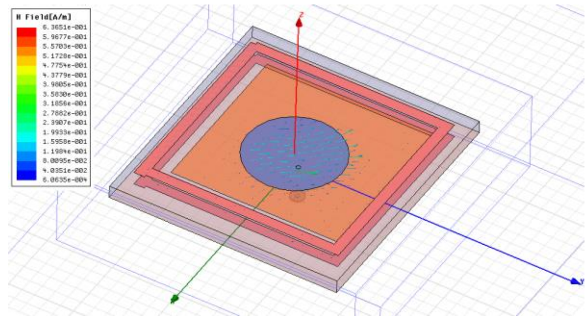

Fig9: Vector H-Field pattern.

F. Current Distrubution

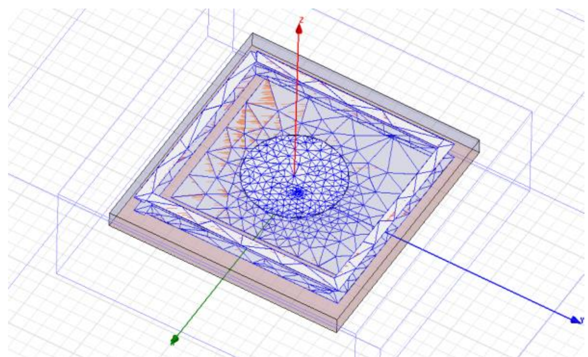

Fig10: Mesh Pattern.

The triangles show the current distribution. Here the number of triangles inside the patch are more than those on the substrate ie.. the current distribution in the patch is more when compared to that inside the substrate as in Fig10.

G. Radiation pattern

The radiation pattern or antenna pattern describes the relative strength of the radiated field in various directions from the antenna, at a constant distance.

Radiation pattern of Gain total:

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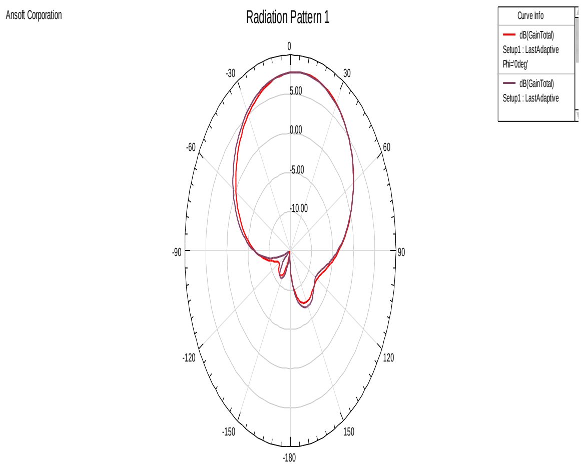

Fig11: Radiation pattern of Gain total.

Radiation pattern of Gain in Theta direction:

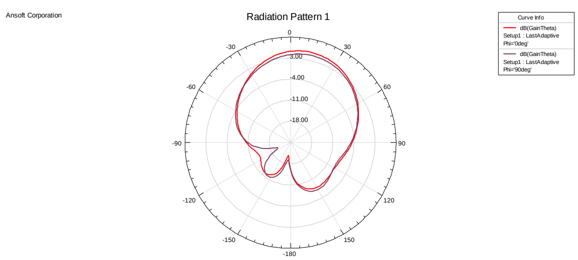

Fig12: Radiation pattern of Gain in Theta direction.

Radiation pattern of Gain in Phi direction

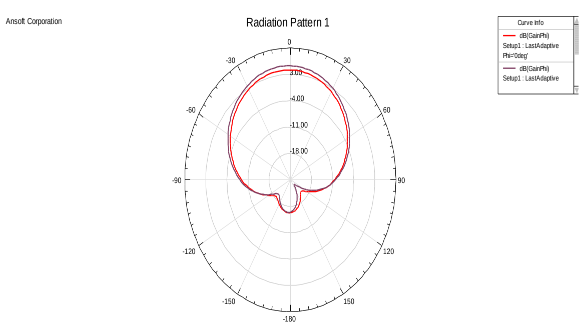

Fig13: Radiation pattern of Gain in Phi direction.

H. Axial Ratio

Axial Ratio is the ratio of peak value in the major lobe direction to peak value in the minor Lobe direction.

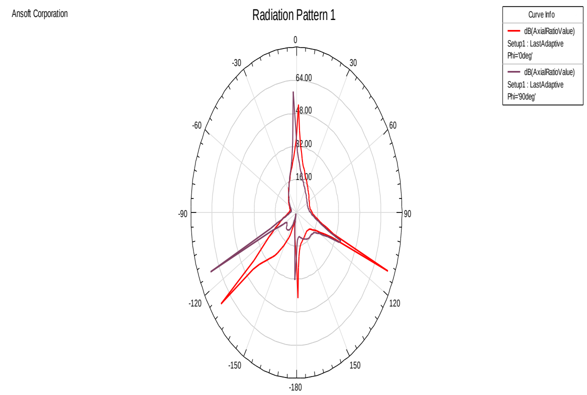

Fig14: Axial Ratio.

I. VSWR

When a transmission line (cable) is terminated by an impedance that does not match the characteristic impedance of the transmission line, not all of the power is absorbed by the termination. Part of the power is reflected back down the transmission line. The forward (or incident) signal mixes with the reverse (or reflected) signal to cause a voltage standing wave pattern on the transmission line. The ratio of the maximum to minimum voltage is known as VSWR, or Voltage Standing Wave Ratio.

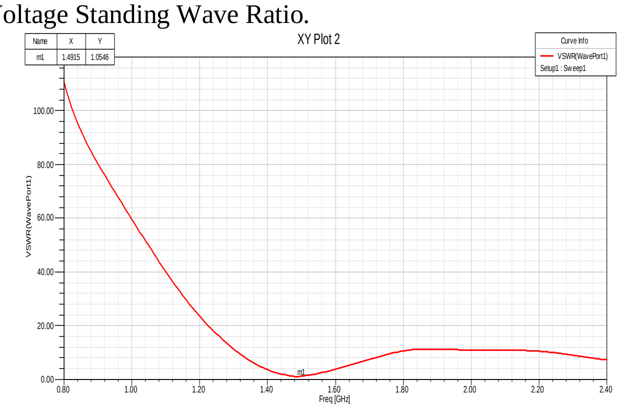

Fig15: VSWR.

For the antenna model VSWR of 1.0546 is obtained.

VI. ANTENNA PARAMETERS

Quantity	Value	Units
Max U	0.0015	W/Sr
Peak Diversity	6.24	
Peak Gain	6.3490	dB
Peak Realized Gain	4.1982	dB
Radiated Power	0.0029	W
Accepted Power	0.0029	W
Incident Power	0.0044	W
Radiation efficiency	0.9955	
Front To Back Ratio	264.2217	
Decay Factor	0	

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VII. CONCLUSION

Thus our proposed UHF RFID reader antenna design able to achieved both near-field & far-field operations. A segmented loop technique along with patch integrated inside the loop gives both near-field and far-field operations at ultrahigh frequency (UHF) range.

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