Design of Far-Field Focusing Circular Patch Antenna at 5.8GHZ for RFID Applications

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Abstract:-
In this paper, a circular patch Microstrip antenna that features electric fields focused in the far-field zone for above 5.8GHz radio frequency identification (RFID) applications is presented. The proposed antenna circular patch Microstrip antenna will be light weight, slim. Cost is also one of main considerations in making these types of antennas. The patch antennas are one of most attractive antennas for integrated RF front end systems. This antenna is capable of enhancing electric field distributions and reduces the insertion loss. The proposed antenna is simulated using Ansoft-HFSS Software and all the output parameters are presented in this paper.

***Keywords*: Circular patch antenna, Electric field distributions, Far-field, insertion loss, RFID**.

1. Introduction:

Recently, a lot of research in RFID technology has been focused on efficient designs of tags and antenna readers. Radio frequency identification (RFID [1], developed around World War II, is an automatic wireless data collection technology with a long history [2]. It provides wireless identification and tracking capability and is more robust than that of barcode.RFID can be used for example in identifying objects in war housing, supply chain management, and other automation processes. In a typical passive RFID system, each individual object is equipped with a small and inexpensive tag (transponder) which comprises an antenna and an application specific integrated circuit (ASIC, or microchip) that is given a unique electronic product code [3].Low frequency (LF, 125-134 KHz) and high frequency (HF, 13.56MHz) RFID systems are short range systems based on inductive coupling between the reader and the tag antennas through a magnetic field. Ultra-high Frequency (UHF, 860-960 MHz) and microwave (2.4 GHz and 5.8 GHz) RFID systems are long-range systems which use electromagnetic waves propagating between reader and tag antennas.

In recent years demand of Microstrip antennas are increased due to its use in high frequency, high speed data communication applications. Microstrip patch antennas are widely used because of their many merits such as the low profile, light weight, low cast and planar also. If the Band width of Microstrip antenna could be widening, it would be very useful for commercial applications.

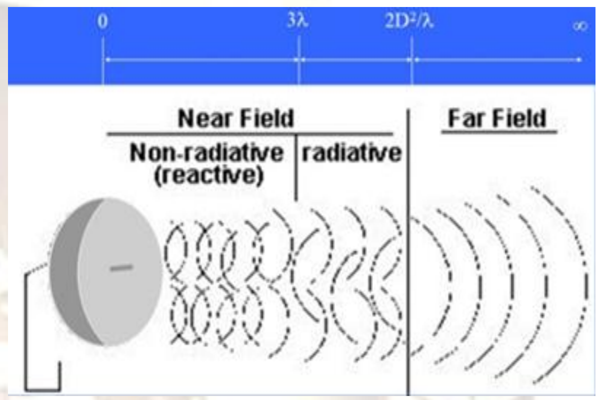

Fig 1: RFID Near-field and Far-field Distribution

2. Antenna design discussion:

Here, we have designed a circular patch Microstrip antenna at 5.8GHZ for RFID applications. Whereas the directivity of the circular patch antenna is more when compared with Conventional Microstrip patch antenna. That is loss is reduced by giving far-field measurements. Hence it has low return loss -16dB shown in figure 3. Far-Field measurements can be performed on Indoor and Outdoor ranges but Near-Field is used only for indoor ranges. Hence Indoor Far-Field range antenna is considered here for RFID. In Far-Field Compact ranges is considered.

In compact range:
High Frequency antenna – Excellent
High Gain – Excellent
Low Frequency – Poor,
Security – Excellent.

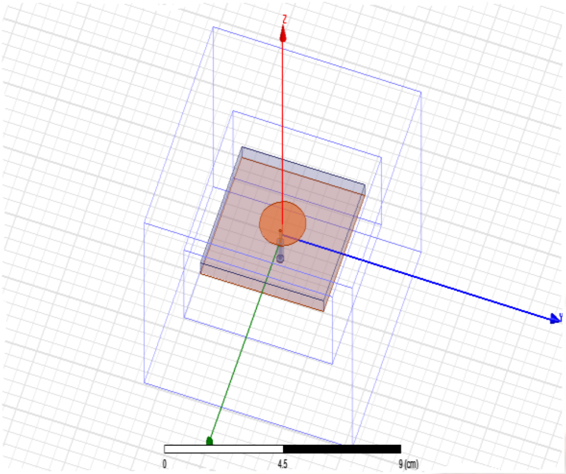

Fig 2: Cross-sectional view of proposed antenna

2.1 Antenna Parameters:

Quantity	Value	Units
Max U	0.23205	**W/Sr**
Peak Diversity	46.154	
Peak Gain	46.058	
Peak Realized Gain	46.581	
Radiated Power	0.06318	W
Accepted Power	0.063313	W
Incident Power	0.06541	W
Radiation efficiency	0.99791	
Front To Back Ratio	1686.1	

Table 1: Antenna Additional Parameters

2.2 Maximum field data:

γE Field	Value	Units	At Phi	AT Theta
Total	13.227	V	40 deg	18 deg
X	12.804	V	45 deg	14 deg
Y	2.4115	V	45 deg	138 deg
Z	6.8287	V	30 deg	46 deg
Phi	11.938	V	85 deg	12 deg
Theta	12.677	V	10 deg	16deg
LHCP	9.9499	V	45 deg	24 deg
RHCP	8.9835	V	20 deg	14 deg

Table 2: Maximum field data

3. Results and discussion:

The simulation and experimental studies of the antenna are done using Ansoft HFSS software respectively. Fig 3 shows the simulated return loss characteristics of the proposed antenna.

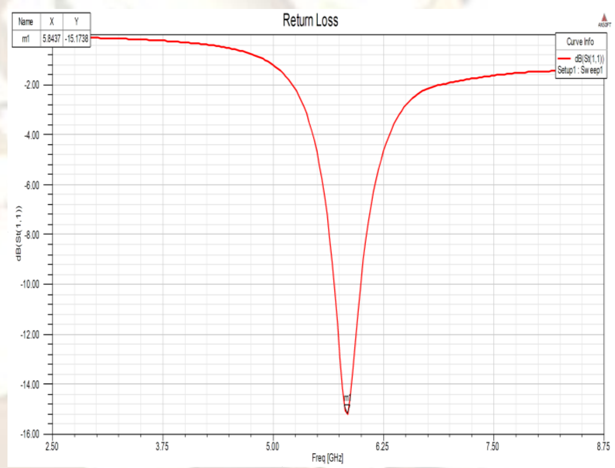

Fig 3: Return loss of the proposed antenna

Fig. 4 shows the simulated Input Impedance characteristics of the antenna. Fig. 5-8 shows the simulated Radiation Pattern of the antenna.

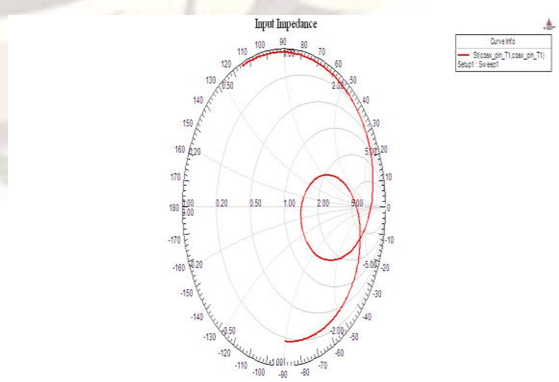

Fig 4: Input Impedance

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

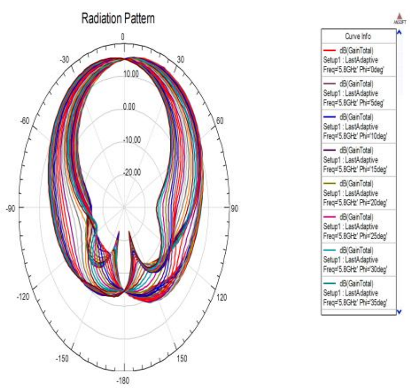

Fig 5: Radiation pattern of Gain Total

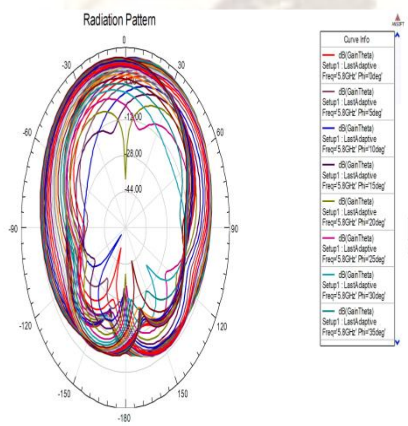

Fig 6: Radiation pattern of Gain Theta

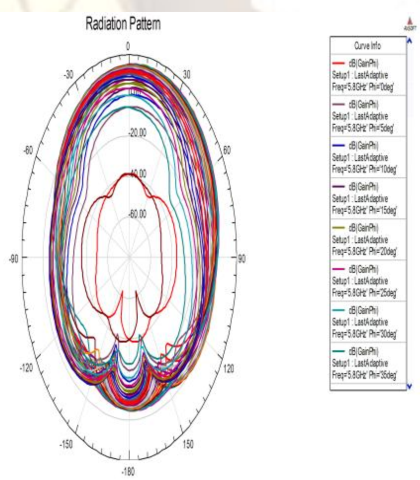

Fig 7: Radiation pattern of Gain Phi

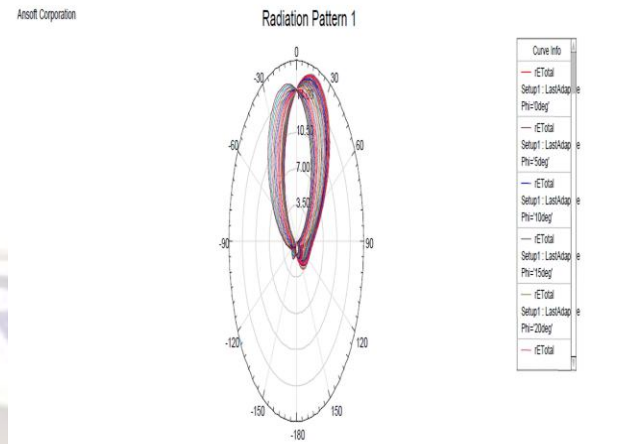

Fig 8: Radiation pattern of rE Total

Fig. 9 shows the simulated 2D Gain of the antenna. Antenna gain can also be specified using the total efficiency instead of the radiation efficiency only. This total efficiency is a combination of the radiation efficiency and efficiency linked to the impedance matching of the antenna. Fig. 10 shows the simulated 3D Gain of the antenna.

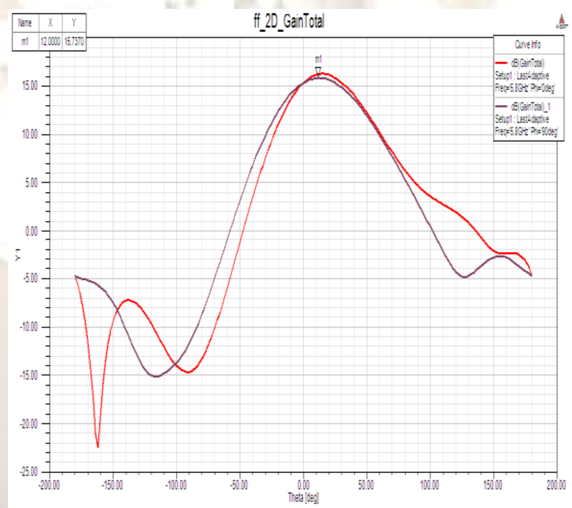

Fig 9: 2D Gain of the antenna

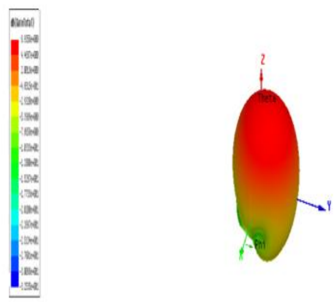

Fig 10: 3D Gain of the antenna

An electric field can be visualized by drawing field lines, which indicates 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. Fig.11 shows the E-field pattern.

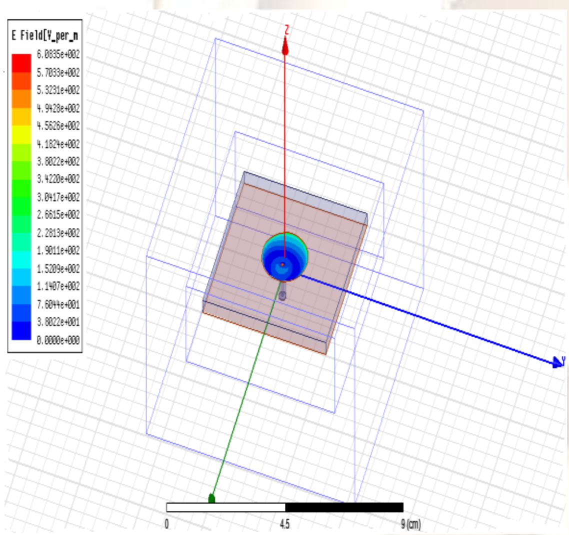

Fig 11: E-field Pattern

In the case of 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. Fig. 12 shows the H-field pattern.

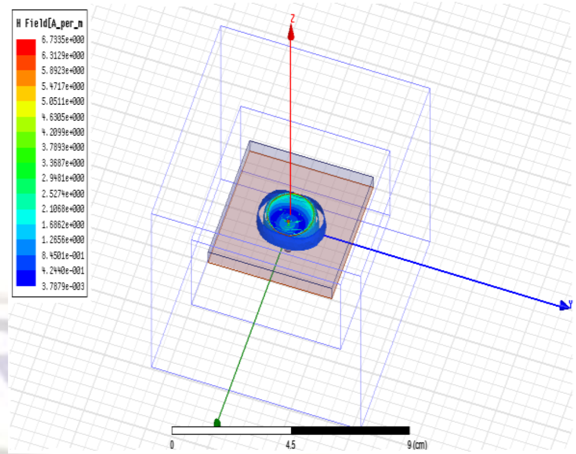

Fig 12: H-field Pattern

Fig 12: shows the current distribution of the antenna.

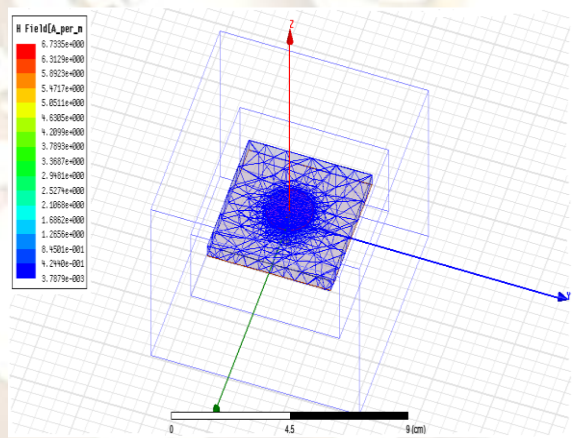

Fig 13: Current distribution of Antenna

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

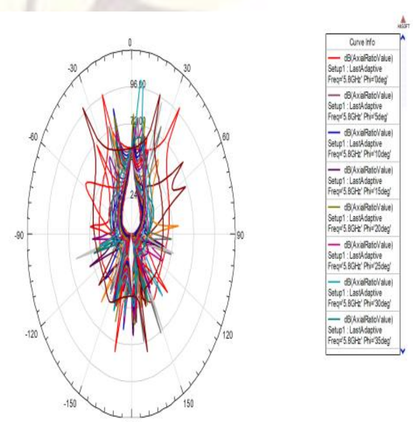

Fig 14: Axial Ratio

We can see that return loss is less than -10 dB. Figure 5-8 shows Radiation pattern of antenna which also giving the satisfactory result. Figure 9 & 10 shows antenna gain with frequency.

4. CONCLUSION:

In this paper Circular patch Microstrip antenna is designed using HFSS, which is focused in the Far-Field region. Far-Field is considered because it is used for both indoor and outdoor ranges and in this design compact range is considered. After designing Circular patch Microstrip antenna, it is simulated in HFSS to obtain return loss, input impedance, gain and we obtain the results accurately. This is used for RFID applications at Microwave frequencies i.e. the proposed Circular patch antenna works at 5.8 GHz.

5. Acknowledgements:

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6. References:

[1] K. Finkenzeller, RFID Handbook: Radio-frequency Identification Fundamentals and Applications, 2nd ed.: Wiley, 2004.
[2] J. Landt, "*The history of RFID*," *IEEE Potentials*, vol. 24, no. 4, Nov. 2005, pp. 8-11.
[3] R. Want, "*An introduction to RFID technology*," *IEEE Pervasive Computing*, vol.5, no.1, pp. 25-33, Jan.-March 2006.
[4] S.Zhong, Z. Sun, X. Tang, and K. Chen, "*Circularly-polarized Microstrip array with low-sidelobe for RFID application*," in *Proc.APMC,* Dec. 2008, pp. 1–4.
[5] Mehmet ABBAK*, Ibrahim TEKIN," *Microstrip Patch Antenna Array for Range Extension of RFID Applications,*" Sabanci University 34956, Istanbul, Turkey.
[6] T. Durga Prasad, K. V. Satya Kumar, V.Santosh Kumar "*Comparisons of Circular and Rectangular Microstrip Patch*," AntennasVol 02, Issue 04; July 2011.
[7] R. Siragusa, P. Lemaitre-Auger, and S. Tedjini, "*Near field focusing circular microstrip antenna array for RFID applications*," in *IEEE AP-S Int. Symp. Dig*., Jun. 2009.

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