Design and Performance of a Compact Microstrip Patch Antenna using Circular slots And Stub for RFID Applications

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Abstract

In this paper on a rectangular substarte two patch's with two slots have been different radius to each other used for radio frequency identification reader applications. The antenna is using a coaxial feed with microstrip stub. The material of patch is copper which is having good conductivity, low cost and stability. The proposed designed antenna have lower substrate of ployflon NORCLAD material which is made from the thermoplastic PPO (Polyphenylene Oxide), have an ideal dielectric constant of 2.55, very uniform. The material of upper substrate is Rogers Duroid. The dielectric constant of Rogers Duroid 5870 is 2.33 and moisture absorption of 0.02. The antenna is designed using HFSS software. When we compared the results it is found that the proposed antenna has better results than the existing one. The overall dimension of the antenna are 118×118×9.801mm^3. Its gain is 7.94 dB over the 10 dB axial ratio and having -39dB Return Loss at 833 MHz to 1033 MHz.

Keywords--*Circular polarization, microstrip patch, radio frequency identification (RFID), slotted patch.*

I. INTRODUCTION

The designed antenna is useful for radio frequency identification, high speed data transmission, wireless communication and to reduce cross talk in wireless transmission system[1]. The radio frequency identification is short range techique uses radio waves for communication. The tag is used as a device which is equal in size of rice grain to target the object and it is identified by the radio waves.

The proposed antenna is consist of a circular slotted embedded on a lower square patch with a microstrip stub and coaxial feed[2]. The material of lower patch is copper which is ductile, have high temperature ability and good electrical conductivity. The dielectric constant of copper is 1. The designed antenna is using a combination of very low cost lower substrate which is ployflon NORCLAD material made from the thermoplastic Polyphenylene Oxide. Lower substrate have dielectric constant of 2.55 and reproducible electrical properties, low loss and are stable over temperature with thermal stability and the material of upper substrate is Rogers Duroid 5870 having reinforced composites are designed for exacting stripline and microstrip circuit applications. The dielectric constant of Rogers Duroid 5870 is 2.33 and moisture absorption of 0.02. It laminates uniform from panel to panel and is constant over a wide frequency range. Rogers Duroid 5870 is used in circuitry for commercial telephone communication, microstrip and stripline applications, air force and military radar systems, missile operating system, airline, point-to-point digital radio antennas[3]. The upper slot and the lower slot are embedded along the diagonal axis on upper patch and lower patch, respectively. The location of both slot is set to achieve maximize polarization radiation. Microstrip stub has attached with the lower patch. It helps to achieve good impedance matching and the UHF range for RFID applications.

II. ANTENNA GEOMETRY AND DESIGN

The designed antenna is a combination of

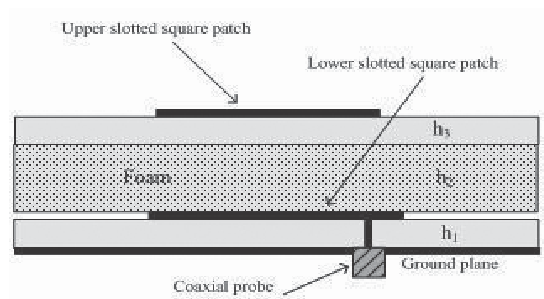

Figure 1. Microstrip Patch Antenna[1].

Table 1 Parameters and values for lower patch

Parameters	Values(mm)
L	72.5
W	67
xo	35.75
Ml	14.62
r_1	15.5

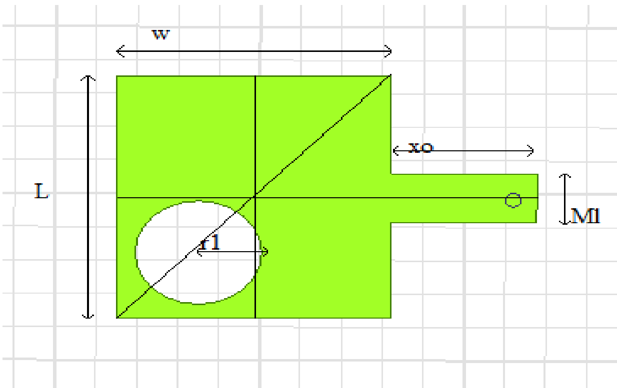

Figure 2. Lower Square Circular Slotted Patch

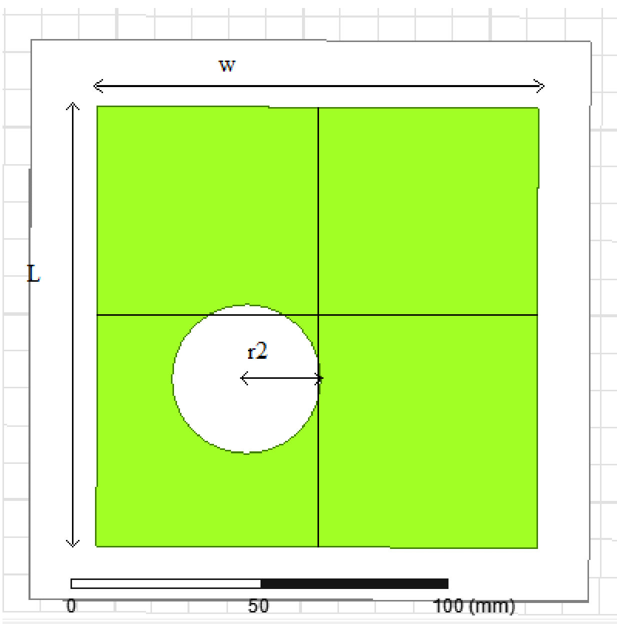

Figure 3. Upper Square Circular Slotted Patch

low cost of lower substrate which is ployflon NORCLAD material and made from the thermoplastic PPO (Polyphenylene Oxide), material of upper substrate is Rogers Duroid 5870 and foam[4]. The length of microstrip stub and location of coaxial feed is used for tuning the impedance matching. The upper square slotted patch is stacked with the help of foam substrate over the lower square slotted microstrip patch. A slot location on the upper square patch is set along the diagonal axis with a radius of r2 .

Table 2 Parameters and Values of Upper Patch

Parameters	Values
L	118
W	118
r2	20

Table 3 Initial Design Assumptions

Parameters	values
Operating Frequency	833-1033MHz
Lower Substrate	Ployflon_NORCLAD
Dielectric Constant	2.55
Upper Substrate	RogersRT/Duroid5870
Dielectric constant	2.33
Lower Patch	Copper
Dielectric constant	1
Upper Patch	Copper
Dielectric constant	1
Dielectric material	Foam
Dielectric constant	1.006

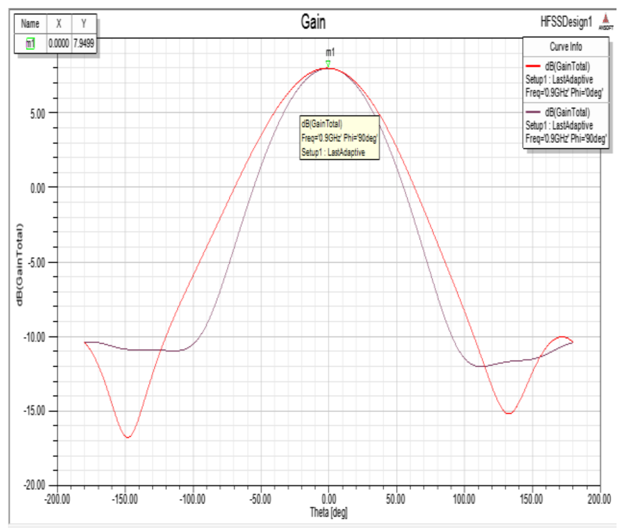

Figure 4. Gain for Circular Slotted Microstrip Patch Antenna.

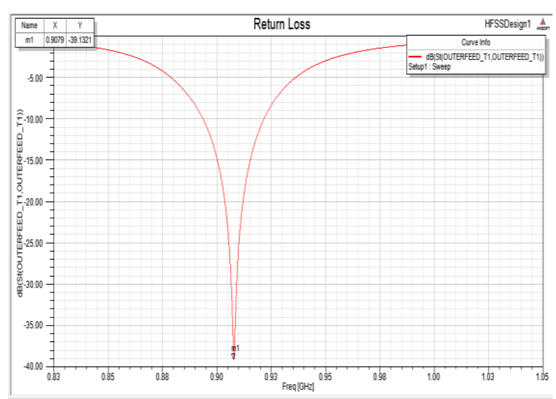

Figure 5. Return Loss for Circular Slotted Microstrip Patch Antenna

III. COMPARING DIFFERENT ANTENNA'S RESULT WITH PURPOSED ANTENNA

A. Results for Rectangular Slotted Microstrip Patch Antenna

The performance of rectangular patch antenna in term of Gain and Return Loss is shown. The antenna has resonant frequency of 833MHz-1033MHz having Gain of 7.94dB return loss of -30dB. The Gain and Return Loss are shown in figure 6. and 7. , respectively.

Table 4 Represents the Parameter and Values of Lower Rectangular Slot Patch

Parameters	L	W	H
values(mm)	30	30	0.001

Table 5 Represents the Parameter and Values of Upper Rectangular Slot Patch

Parameters	L	W	H
Values(mm)	40	40	0.001

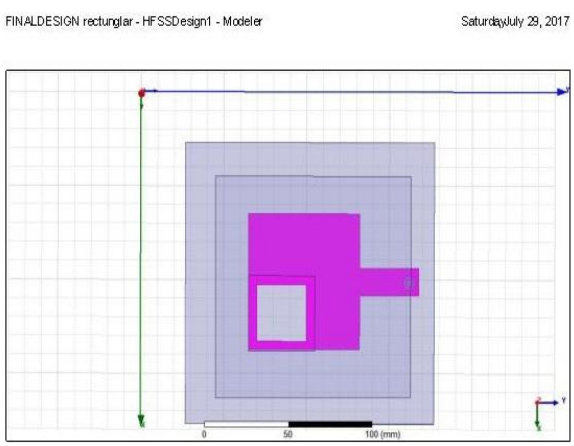

Figure 6. Represents the Designed Rectangular Slotted Patch Antenna.

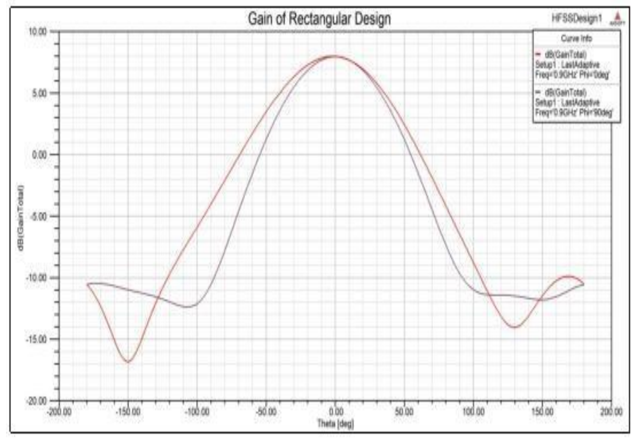

Figure 7. Gain for Rectangular Patch Antenna

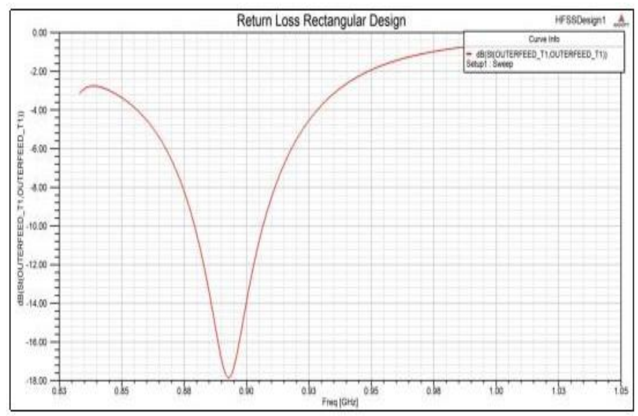

Figure 8. Return Loss for Rectangular Patch Antenna.

B. Results for Dual Circular Slotted Patch Antenna:

The performance of dual circular slotted patch antenna in term of Gain and Return Loss is shown. The antenna has resonant frequency of 833MHz-1033MHz having Gain of 7.94dB and return loss of -17 dB. The Gain and Return Loss are shown in figure 10 and 11, respectively.

Table 6 Represents the Parameter and Values of Upper Circular Slot(S1) Patch

Parameters	R	H
Values(mm)	20	0.001

Table 7 Represents the Parameter and Values of Upper Circular Slot(S2) Patch

Parameters	R	H
Values(mm)	15	0.001

Table 8 Represents the Parameter and Values of Lower Circular Slot Patch

Parameters	R	H
Values(mm)	15.5	0.001

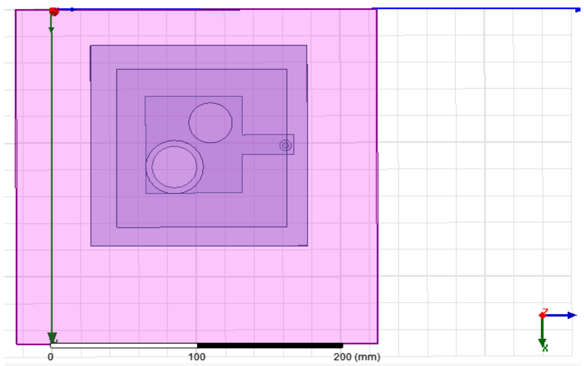

Figure 9. Represent the Design of Double Circular Slot Microstrip Patch Antenna.

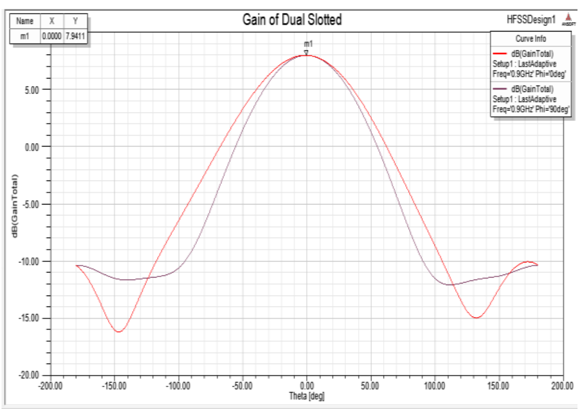

Figure 10. Gain for Dual Circular Slotted Patch Antenna.

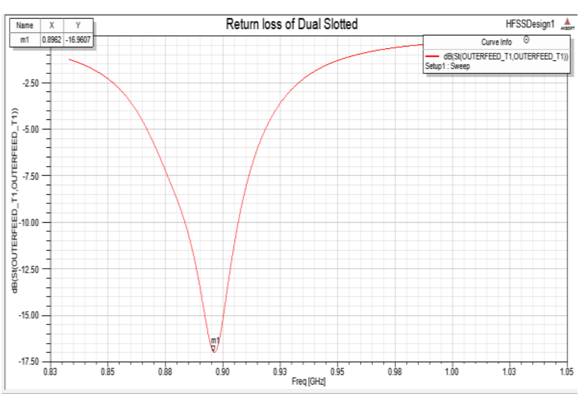

Figure 11. Return Loss For Dual Circular Patch Antenna.

C. Results for Tripple Circular Slotted Patch Antenna:

The performance of tripple circular slotted microstrip patch antenna in term of Gain and Return Loss is shown. The antenna has resonant frequency of 833MHz-1033MHz having Gain of 7.93 dB and return loss of -17 dB. The Gain and Return Loss are shown in figure 13 and 14, respectively.

Table 9 Represents the Parameter and Values Of Upper Circular Slot(S1) Patch

Parameters	R	H
Values(mm)	20	0.001

Table 10 Represents The Parameter And Values Of Upper Circular Slot(S2) Patch

Parameters	R	H
Values(mm)	10	0.001

Table 11 Represents the Parameter and Values of Upper Circular Slot(S3) Patch

Parameters	R	H
Values(mm)	10	0.001

Table 12 Represents the Parameter and Values of Lower Circular Slot Patch

Parameters	R	H
Values(mm)	15.5	0.001

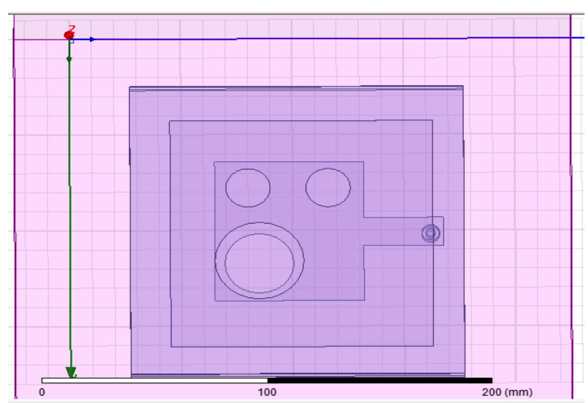

Figure 12. Represent the Design of Tri Circular Slot Microstrip Patch Antenna.

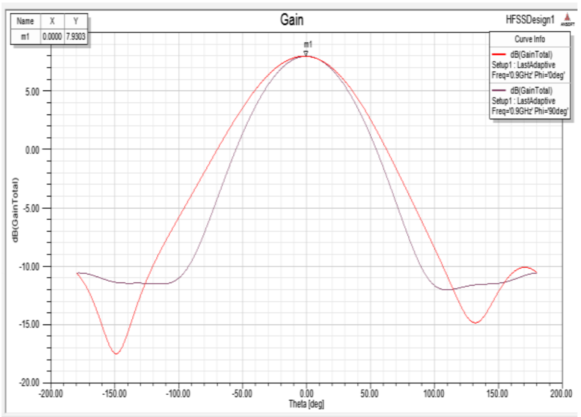

Figure 13. Gain for Tripple Circular Patch Antenna.

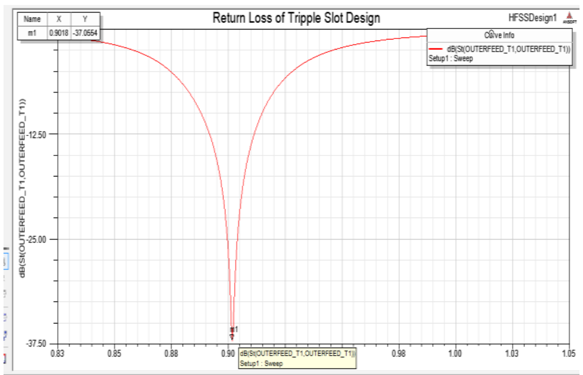

Figure 14. Return Loss For Tripple Circular Patch Antenna

D. *Results for Quardruple Circular Slotted Microstrip Patch Antenna:*

The performance of tripple circular slotted microstrip patch antenna in term of Gain and Return Loss is shown. The antenna has resonant frequency of 833MHz-1033MHz having Gain of 7.94dB return loss of -37.50 dB. The Gain and Return Loss are in figure 16 and 17, respectively.

Table 3.15 Represents the Parameter and Values of Upper Circular Slot(S1) Patch

Parameters	R	H
Values(mm)	20	0.001

Table 3.16 Represents the Parameter and Values of Upper Circular Slot(S2) Patch

Parameters	R	H
Values(mm)	10	0.001

Table 3.17 Represents the Parameter and Values of Upper Circular Slot(S3) Patch

Parameters	R	H
Values(mm)	10	0.001

Table 3.18 Represents the Parameter and Values of Upper Circular Slot(S4) Patch

Parameters	R	H
Values(mm)	10	0.001

Table 3.19 Represents the Parameter and Values of Lower Circular Slot Patch

Parameters	R	H
values(mm)	15.5	0.001

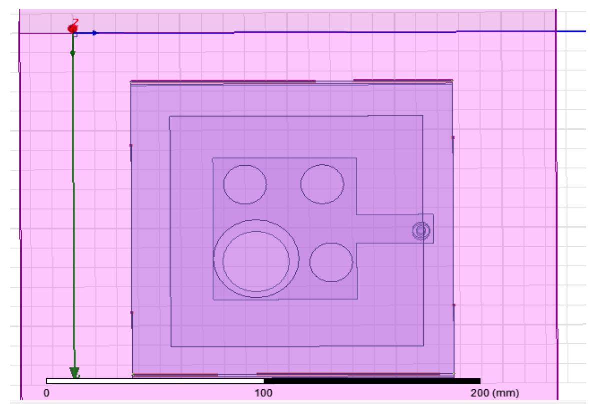

Figure 15. Represent the Design of Quardruple Slot Patch Antenna

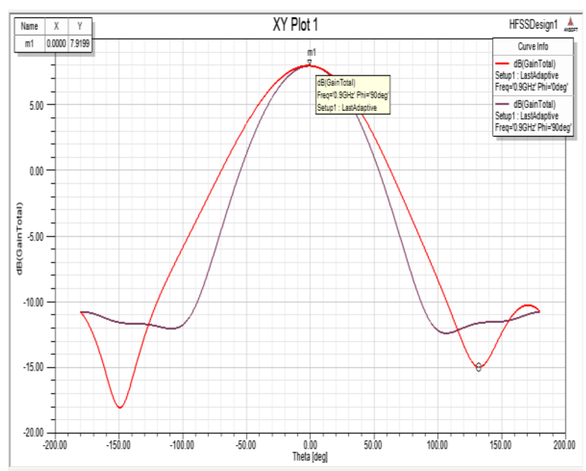

Figure 16. Gain for Quardruple Circular Patch Antenna.

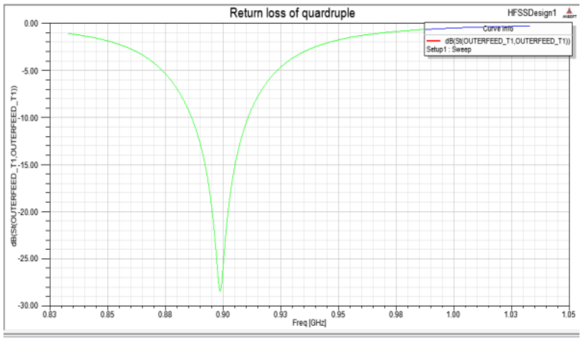

Figure 17. Return Loss for Quardruple Circular patch antenna

IV. COMPARISON

The performance of proposed slotted microstrip antenna, configuration has been compared with reference (base) antenna in terms of return loss, gain. It has been observed that proposed antenna have better results as compared to reference antenna and configuration. The performance of proposed antenna designs and reference antennas has been compared in the table 4.1.

Table 4.1 Represents the Gain and Return Loss.

Parametes	Gain	Return Loss
Base paper	6dB	-33dB
Dual Circular Slotted	7.94dB	-17dB
Rectangulr slotted	7.94dB	-18dB
Quardruple Slotted	7.94dB	-28dB
Tripple circular Slotted	7.92dB	-37.50dB
Slotted microstrip Antenna	7.94dB	-39dB

V. RESULTS FOR SLOTTED MICROSTRIP PATCH ANTENNA

The simulation process will provide return loss plot, gain of the designed antenna. The slotted microstrip antenna has resonant frequency of 833MHz-1033MHz as shown in figure 4 and 5 having return loss of -39dB. The slotted microstrip antenna has gain of 7.94dB at 833MHz-1033MHz resonant frequency. The return loss of an antenna is represented by S11 and describes that how much of the power is reflected back due to improper impedance matching at the transmitting end. The improper impedance matching at a transmitting end of an antenna results in reflection of incident power towards the source. The return loss of an antenna is usually expressed as a ratio in decibels (dB). The return loss plot shows the antenna resonating frequency, which is the frequency of lowest value of return loss in dB on S11 plot.

VI. CONCLUSION

The proposed antenna improves the Return loss and Gain. The use of air as a substrate reduces the surface wave losses which is further responsible to improve the gain and directivity of the proposed microstrip patch antennas. The combination of both slot and air substrate, has been successfully implemented in order to reduce both copper losses and surface wave losses. The antenna plays essential role to enhance the gain and directivity. The purposed designs are simple, efficient, and easy to fabricate. The highly efficient printed circuit board technology made possible the fabrication of the simulated antenna designs. It has been observed that the proposed configuration can be used in high gain and better return loss applications.

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