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Design of circularly polarized micro strip patch array antenna using RT DUROID, POLYSTERENE & FR4 EPOXY substrate materials for Bluetooth and wlan applications

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Abstract*— The design of coaxial feed network to produce circular polarized micro strip patch array antenna is for different substrates presented in this article. A circularly polarized patch antenna is realized as an array of slotted patches whose diagonal corners are cut off and whose feed lines meet at central point with square path on which substrates RTdurouid, polystyrene and FR4 Epoxy materials. The antenna is simulated and verified for the frequency range of 1.5 GHz to 4.5 GHz Bluetooth and WLAN

***Index Terms*— Circular Polarization, Micro Strip Antennas, , Bluetooth, WLAN.**

I. INTRODUCTION

An antenna is specialized transducer that converts radio frequency (RF) fields into alternating current (AC) or vice versa. Among so many types of antenna, micro strip patch antenna play very important role in communication system for its low profile, large bandwidth and less cost. The micro strip patch antenna consists of radiating patch on one side of dielectric substrate, which has ground plane on other side. The patch conductors can assume virtually any regular side to simplify the analysis. The dielectric constant Er of substrate enhances the fringe fields that account for radiation. Various types of substrates having a large range of dielectric constant and loss tangents have been developed and verified.

Circularly spellbound wave delivered by passing directly enraptured light through a quarter wave plate at a point of 45 degrees to the optic pivot of the plane. Now a day's interest in compact circularly polarized antennas has been increased.
Now days, circularly polarized antenna at a particular frequency has increased. The circular polarized antennas can be classified into two different types namely, Single feed type and Dual feed type. Dual feed patch which uses an external power divider network, which yield a wider axial ratio, bandwidth and narrow VSWR.To obtain, wider axial ratio, high gain, narrow VSWR using single fed, direct coupled array antenna can be used. And to improve the gain and directivity of the antenna, array antennas can be used.

Many applications require radiation characteristics that may not be achievable by a single element, so an aggregate of radiating elements in an geometrical and electrical arrangement will result in desired radiation characteristics.

HFSS is a method for financially accessible limited component solver for electromagnetic field examination structure. Acronym, it was initially standing a high recurrence structure test system. This channel, transmission lines, and one of a few economically accessible devices used to outline the radio wire and RF plan components of the complex electronic circuits, Every HFSS, the acclaimed FEM components and Ansoft's items and glimmer. Ansoft Corporation was procured by ANSYS for after.

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II. DESIGN SPECIFICATIONS

In this technique, reception apparatus is demonstrated as multiport system. This planar model is dealt with as a misfortune less resonator amid examination. The whole radiation resistance system is dealt with as one multi-port system "β" as appeared underneath and equal "LC" equal is given beneath

$$\begin{bmatrix} vp \\ vc \\ vd \end{bmatrix} = \begin{bmatrix} zpp & zpc & zpd \\ zcpv & zcc & zcd \\ zdp & zdc & zdd \end{bmatrix} \begin{bmatrix} Ip \\ Ic \\ Id \end{bmatrix} \quad \text{----------- (1)}$$

Where, p = un-connected ports of the various segments of

C and d = represents inter connected ports.

$$Z^\wedge_r = Z^\wedge_{pp} + (Z^\wedge_{pc} - Z^\wedge_{pd}) \, 1/Z_{ep} \quad \text{--------------------- (2)}$$

The electric current I_p fed into the pth port, the voltages at the inter connected ‘c’ and‘d’ ports are given by,

$$V_c = V_d = [Z^\wedge_{cp} + [Z^\wedge_{cc} - Z^\wedge_{cd}] \, Z^\wedge_{cp}] * I_p \quad \text{------------------ (3)}$$

The reactance's of proposed receiving wire for entomb associated ports and the joined reactance's of bury associated and detached ports are supplanted with inductors and capacitors (C1, C2) in which the inductance I1 relates to transverse and longitudinal thin strips. Capacitance C1 is capacitance triangular patch and C2 is hole capacitance between triangular patch and the radiation fix and structure is appeared in figure.

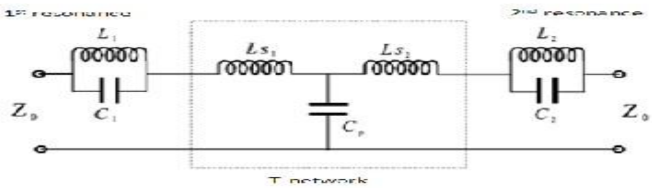

Fig.1 LC equivalent circuit for slots

This antenna array consists of four 45 x 46 mm^2 rectangular patches distributed over one horizontal plane in a circular formation with 90° spacing. Inserting a nearly-square slot of size 10 x 11 mm^2 into each rectangular patch and diagonally truncating two corners of the patch will cause excitation of two orthogonal modes with approximately equal magnitude and 90° relative phase, thus creating the required circular polarization. Antenna is mounted 1 cm above a 170.5 x 170.5 mm^2 ground plane with substrate selective as dielectric substrate. The feed network has been designed to permit equal and co-phased feeding of all the patches from a central pin at which the feed lines are parallel connected and which is fed from an SMA connector on the underside of the ground plane. For simplicity of construction, the feed lines use the same spacing as the patches.

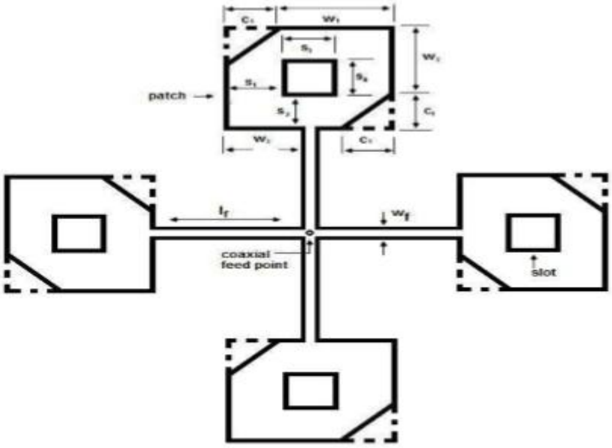

Fig.2 Model of Patch

Dielectric constant of FR4 EPOXY as a substrate is 4.4. Using the design theory and calculations the present antenna has been designed and optimized for the optimal antenna configuration using HFSS (a FEM based simulation solver). The antenna structure is presented in Figure. The fabricated prototype of designed antenna is shown in figure. The detailed dimensions of radiating patch feed is tabulated in table1.

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Table1. Patch Dimensions

W1 34mm	W2 33mm	W3 21.75mm	W4 9.75mm	S1 17.4mm	S2 16mm
S3 34mm	S4 10mm	Lf 31.25mm	Wf 2.5mm	C1 12mm	Z 0.5mm

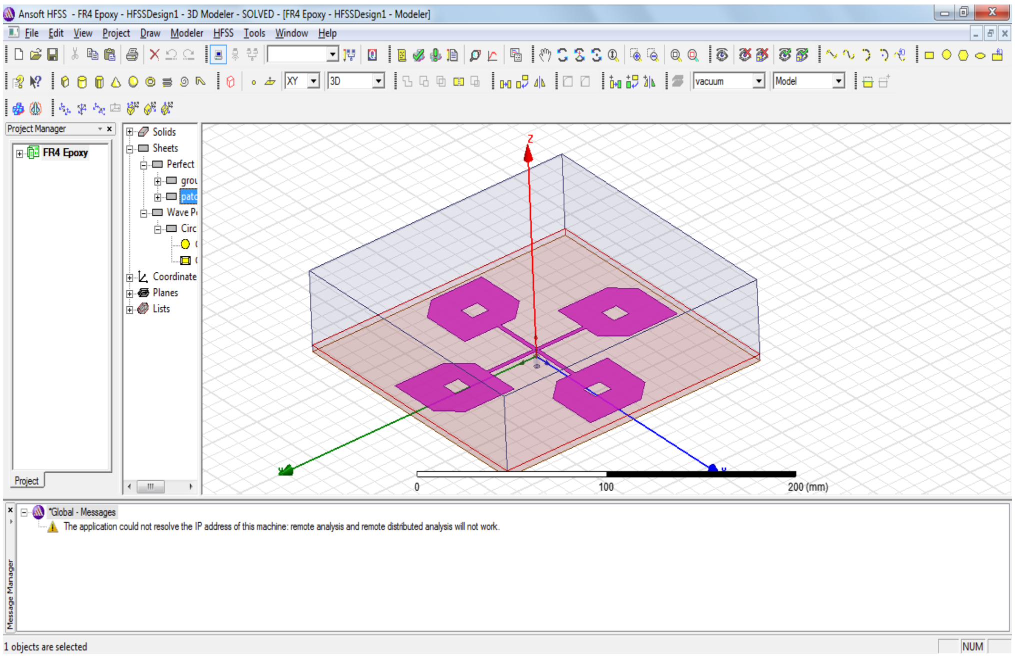

Fig.3 Top view of Designed MSPA in HFSS

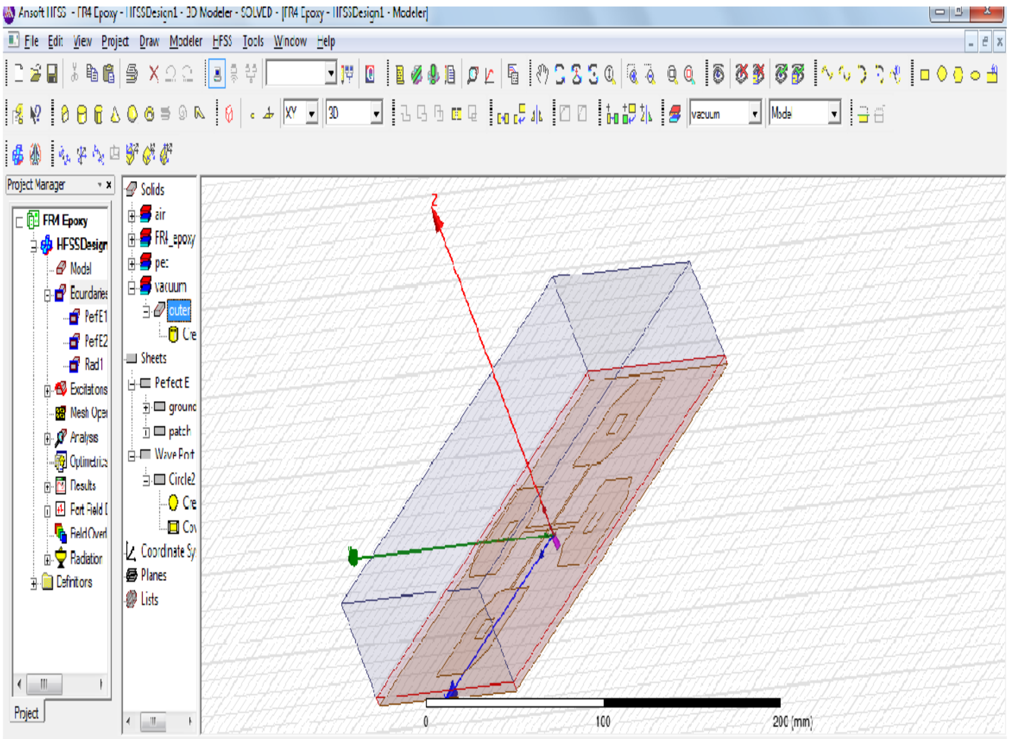

Fig.4 Side view of Designed MSPA in HFSS

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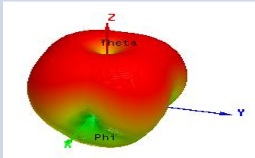
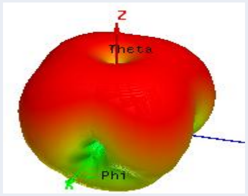
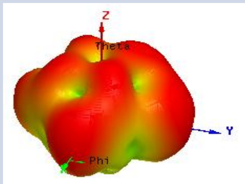
III. COMPARATIVE ANALYSIS BETWEEN SUBSTRATES USED

S No.	SUBSTRATES USED	CONNECTOR RETURN LOSS	RADIATION PATTERN	3D POLAR PLOT	AXIAL RATIO
1.	RT DUROID	No Convergences are obtained above 10db	Covers very small area		Poor performance
2.	POLYSTYRENE	Antenna is converges at 3 different frequencies i.e., 3.75Ghz,4.29Ghz and 4.43Ghz	Covers moderate area		Moderate performance
3.	FR4 EPOXY	Antenna is converges at 3 different frequencies i.e., 1.5Ghz,3.24Ghz and 3.84Ghz	Covers large area		Good performance

IV. RESULTS AND DISCUSSIONS

1. Results of RT Duroid

1.1 Radiation pattern

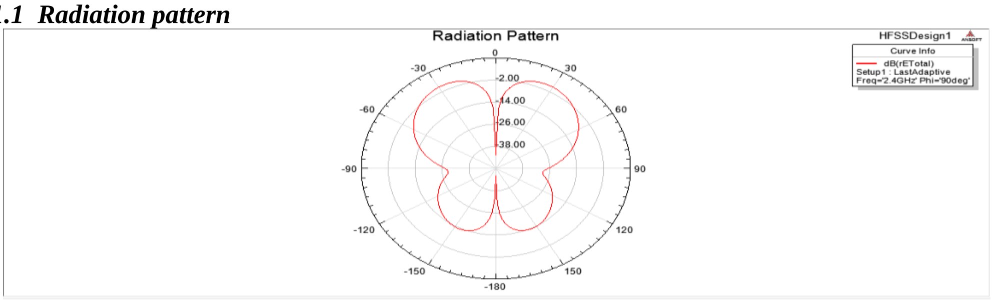


Fig. 1.1. Radiation Pattern of RT Duroid

The radiation pattern of RT Duroid substrate antenna isshown in Fig 1.1 obtained with less coverage of area.the size of minor lobes are large.

1.2 Return loss

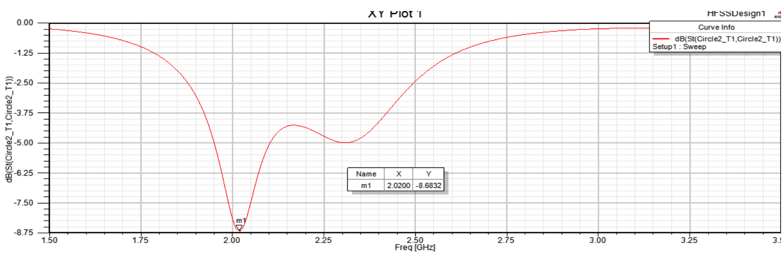


Fig.1.2. Connector return loss of RT Duroid

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The Connector return loss of RT Duroid substrate antenna is obtained very poor that it can not exceed the value of -10 db.And also antenna converges at single frequency 2.05 Ghz with -8.75db is obtained in XY Plot shown im Fig 1.2.

1.3 Axial Ratio:

The Axial ratio of RT Duriod material is obtained and shown in Fig 1.3 which shows that antenna is Circularly polarized antenna.

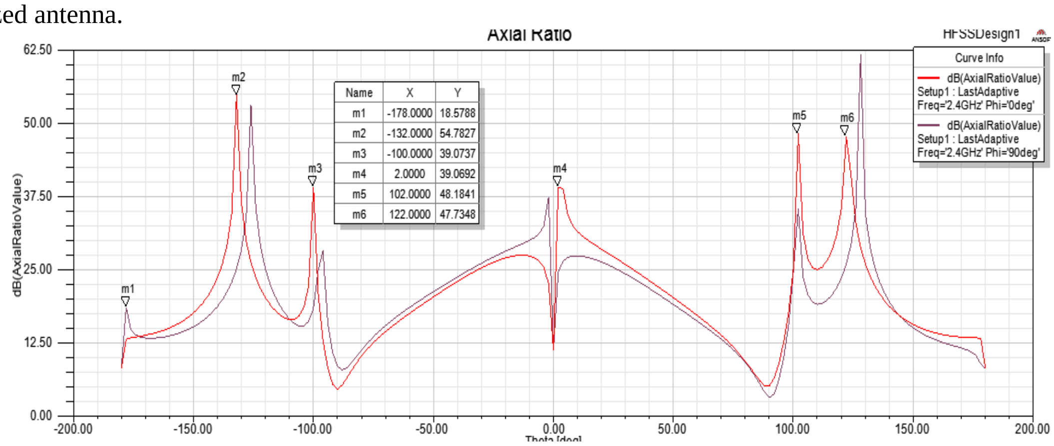

Fig.1.3. Axial Ratio of RT Duroid

1.4 3D Polar Plot:

The3D polar Plot of RT Duriod material is obtained and shown in Fig 1.4

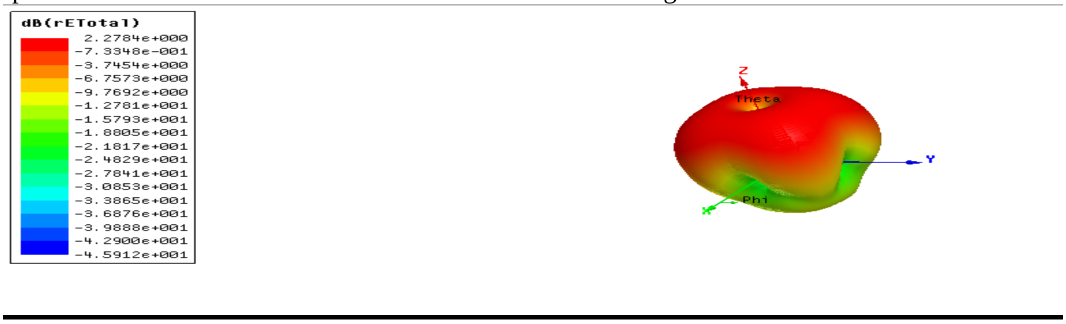

Fig.1.4. 3D Polar Plot of RT Duroid

2. Results of polystyrene

2.1 Radiation pattern:

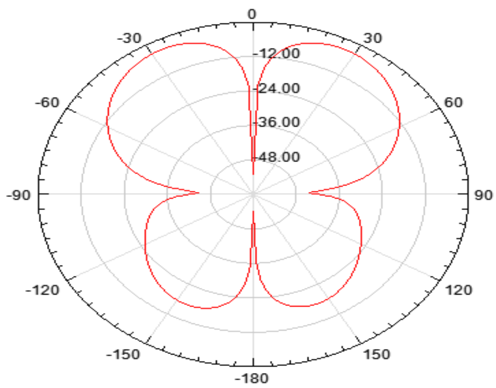

Fig.2.1. Radiation Pattern of polystyrene

The radiation pattern of Polysterene substrate antenna isshown in Fig:2.1 with less coverage of area.the size of minor lobes are medium .But as compare to the RT Duroid substrate MSPA,It is better than the substrate RT Duroid MSPA.

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2.2 Return loss:

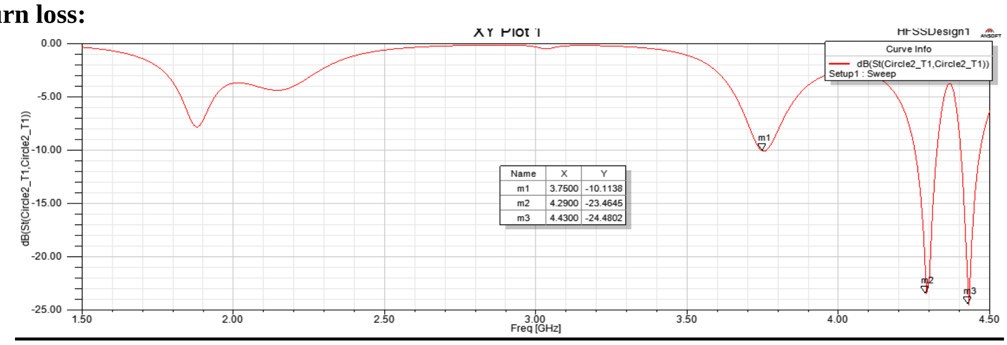

Fig.2.2. Connector Return loss of polystyrene

The Connector return loss of Polysterene substrate antenna shown in Fig: 2.2 is obtained better than the RT Duroid that it can exceeded the values of above -10 db with two converged frequencies at 4.25 & 4.45 Ghz respectively. As compared to the RT Duroid substrate antenna converges with large bandwidth.

2.3 Axial Ratio:

The Axial ratio of RT Duriod material is obtained and shown in Fig 2.3 which shows that antenna is Circularly polarized antenna.

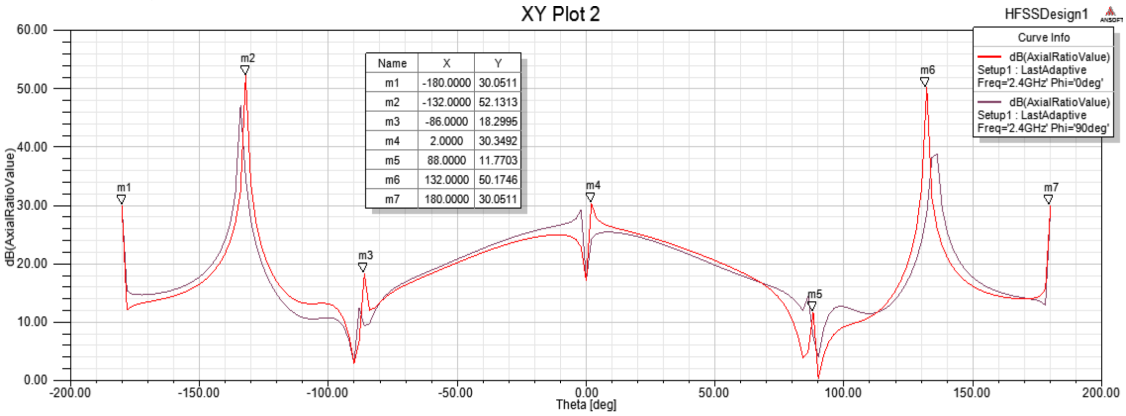

Fig.2.3. Axial Ratio of polystyrene

2.4 3D Polar Plot:

The3D polar Plot of RT Duriod material is obtained and shown in Fig 2.4

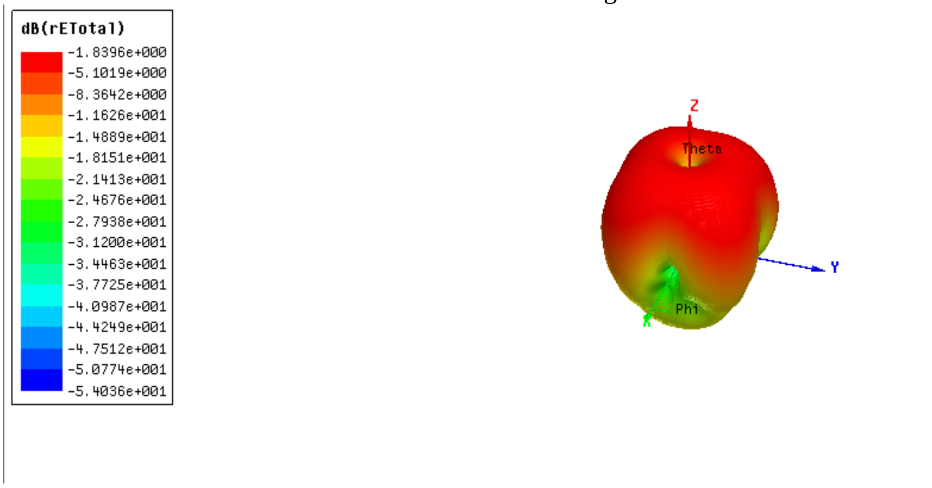

Fig.2.4. 3D Polar plot of polystyrene

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3. RESULTS OF FR4 EPOXY

3.1 Radiation Pattern:

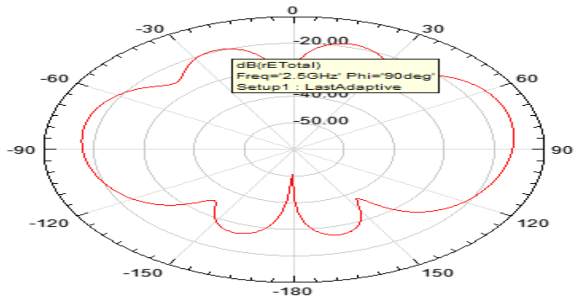

Fig 3.1. Radiation Pattern of FR4 Epoxy

The radiation pattern of FR4 Epoxy substrate antenna shown in Fig: 3.1 is obtained with more coverage of area.the size of minor lobes are less .As compare to the Polysterene substrate MSPA,It is better than the substrate Polysterene MSPA.

3.2 Return Loss:

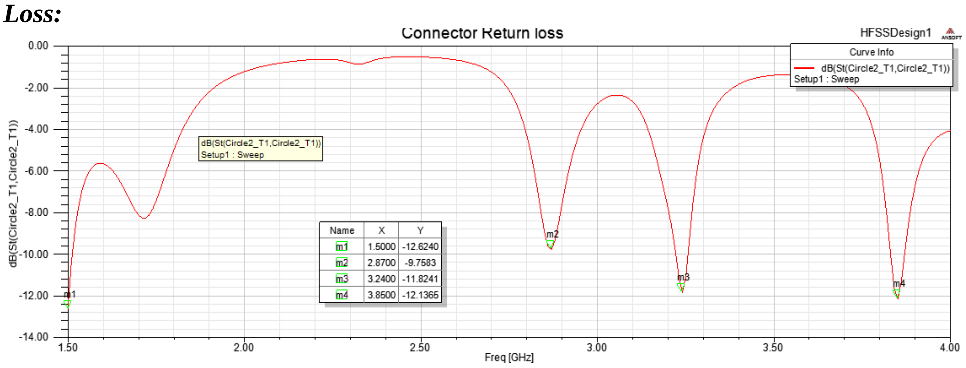

Fig 3.2. Connector Return loss

The Connector return loss of FR4 Epoxy substrate antenna shown in fig: 3.2 is obtained better than the Polysterene that it can exceeded the values of above -10 db with four converged frequiencie at 1.5, 3.25 & 3.86 Ghz respectively. As compared to the Polysteren substrate antenna ,this antenna is high gain.

3.3 Axial Ratio

The Axial ratio of RT Duriod material is obtained and shown in Fig 3.3 which shows that antenna is Circularly polarized antenna

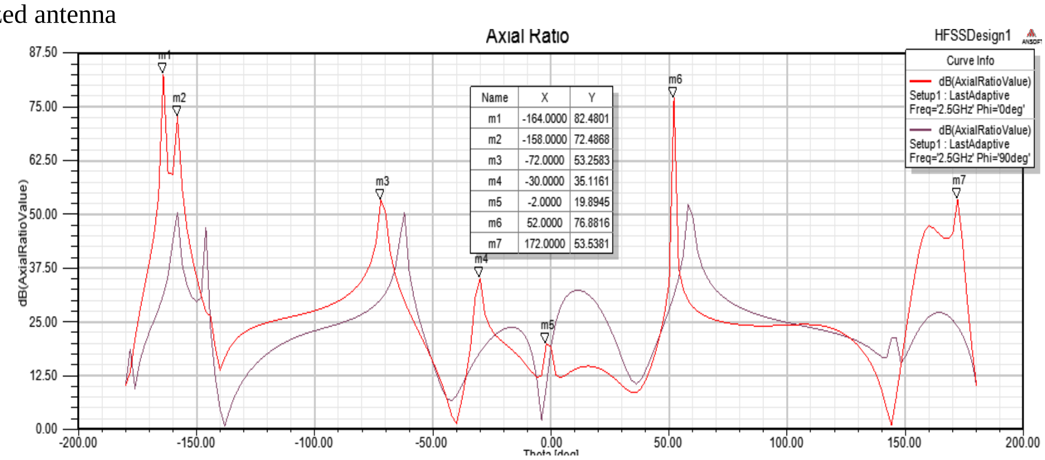

Fig.3.3. Axial Ratio

3.4 3D Polar Plot:

The3D polar Plot of RT Duriod material is obtained and shown in Fig 3.4

Fig .3.4. 3D Polar plot

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