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Comparative Study of Microstrip Patch Antenna with Different Shapes and its Application

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Abstract - *numerous benefits inclusive of: smooth to configure, low weight and coffee value make microstrip patch antenna (MPA) the primary preference for wi-fi communique system. The shape of the patch antenna includes dielectric fabric in among radiating patch and floor plan. In this paper we gift the comparative overall performance evaluation of four exceptional formed antennas. The shapes taken into don't forget are E, T, H and F. The antenna is designed to function at is 2.four GHz. The consequences of various antenna parameters inclusive of go back loss VSWR, radiation pattern, advantage and directivity are analyzed on exceptional frequency bands. The E-formed patch antenna is determined tons higher than the others with ordinary advantage of 7.2 dB at 2.four GHz. Which is appropriate for RFID reader application. Simulation is achieved the usage of High Frequency Structure Simulator (HFSS) antenna simulation tool.*

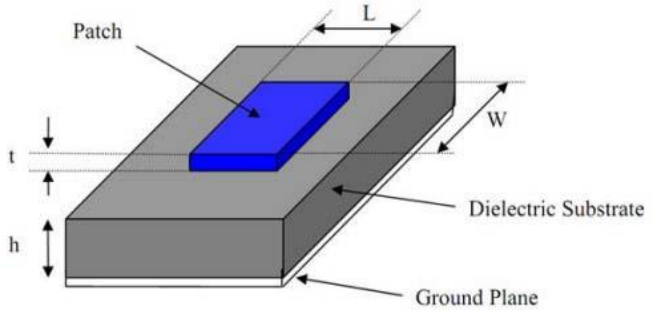
Key Words: Microstrip patch antenna; E-Shaped; T-Shaped; H-Shaped; F-shaped; VSWR; Return Loss; Radiation pattern; HFSS; MPA

1. INTRODUCTION

In the virtual technology cutting-edge verbal exchange gadget needs using compact, well matched and low priced antennas. An antenna is an electric powered inducer that's used to convert electric waves into electromagnetic waves and electromagnetic waves into electric waves. An antenna emits radiations, whilst its contemporary-day in the conductor is modified both with the aid of using growing or lowering the contemporary-day in a instantly wire. This reasons discontinuity in the conductor which makes the antenna radiate[1]. Microstrip patch antennas own a whole lot of benefits over trendy antennas, which include lighter weight, decrease volume, much less cost, low profile, smaller in dimension, easy fabrication and conformity [2] . Due to their compact length and planar shape microstrip they may be utilized in quantity of programs which include radars, telemetry, navigation, radio frequency identification (RFID), biomedical systems, cellular and satellite tv for pc communications, missile systems, international positioning gadget (GPS) for far off sensing and etc [3].A preferred layout of MPA particularly includes 3 additives i.e. patch, substrate and floor aircraft. A copper made a part of is known as as radiating patch is and is connected at the top layer even as the floor aircraft is located at the decrease layer of dielectric substrate as proven in discern 1 [4] .MPAs were certainly considered one among the best candidate for wi-fi programs because of its conformability and to gather any geometrical form and dimension. MPAs were classified into 4 simple categories[5] . These antennas may be designed into diverse designs and shapes relying at the requirement of the parameters. Patch antennas may be of Rectangular, Square, Triangular and round shapes as nicely. Comparatives observe of various shapes of patch antennas is proven in [6], the meander antenna is proved to be higher than round, square and rectangular with Return loss of -26.60 dB and VSWR cost of 1.09. The round and square MPAs are commonly favored due to their easy layout and variety of programs as they offer flexibility with feedline, variety of frequency operation, more than one polarization and higher bandwidth. Every alternate withinside the layout of the patch can end result into a brand new software. An specific technique for round antenna is proposed in [7] with aperture coupled line fed. A square and round patch antenna running in X band at resonant frequency of 10 GHz is in comparison on the idea overall performance [8], wherein square patch antenna is located appearing higher than the round. The microstrip antennas can in addition be changed for diverse programs, they may be designed in shapes of E, Z, T, S, H and F as nicely[9] , discusses 4 differentshaped antennas and their performances. The assessment of version withinside the antenna residences because of alternate withinside the form is provided. An E -formed with functionality of switching its polarization in each the path i.e. left hand and proper round polarization [10], the designed antenna particularly objectives IEEE 802.11b/g frequency band (2.four-2.5GHz) for wi-fi verbal exchange systems. 8.7 dB most advantage with effectiveness in bandwidth is acquired with

symmetry on polarization modes. A U-formed shape with folded hands for wi-fi programs is proposed in [11], the evaluation of the outcomes located that proposed layout has operating variety of 2.four-2.484 GHz. The residences of antenna are located well matched for such software. These antennas because of flexibility of layout and length are favored in frame wearable programs. Many appropriate designs are proposed with the aid of using researchers with inside the domain, In [12], a planar inverted-F of spiral form is provided. The bodily dimensions of the proposed are decreased with the aid of using introducing aggregate technique among geometrical amendment and planar Inverted-F. The proposed antenna

is examined with the aid of using hardware measurements and has the frequency of 911 MHz with -10dB advantage and operating bandwidth of 20MHz at -37.79dBi



advantage. WLAN networks also are certainly considered one among major software of MPAs. WLANs are able to handing over records switch price of 600Mbps.Slotted and Non-Slotted layout procedures also are introduced. A slotted H-formed with properly traits at 2.four GHz is provided in A new technique for circularly polarized antenna with axial ratio (AR) beam width and wideband is proposed in [14], the proposed dipole "S" form is linearly polarized. The proposed layout is located appropriate for the Global Navigation Satellite Systems (GNSS).

In this paper we've centered at the overall performance of the one-of-a-kind formed antennas to choose the only for higher programs. We have designed and studied E-formed, T-formed, F-formed and S-formed antennas to look the version withinside the antenna residences at one-of-a-kind dimensions. We located that E-formed appearing nicely with properly advantage, VSWR and RL values. The designed antenna is located appropriate for the RFID reader software. The paper is classified as: Section II discusses the technique and layout of the antennas. Section III and IV talk the outcomes and end respectively.

2. METHODOLOGY

A.Proposed Antenna Geometry

The geometry of a easy MPA accommodates of a patch that

$$W_p = \frac{c}{2f_o}\left(\frac{2}{\epsilon_r+1}\right)^{\frac{1}{2}} \quad (1)$$

$$L_p = \frac{1}{2f_o\sqrt{\epsilon_{reff}\ \mu_o\epsilon_o}} - 2\Delta L \quad (2)$$

is a radiating part, dielectric substrate and a floor aircraft which presents isolation among EM waves as proven in parent 1 The proposed MPA is designed the use of microstrip line inset feeding method, due to the fact this method presents a clean floor to the antenna. The working frequency to layout unique antennas is taken as 2.four GHz. This frequency is unlicensed and is utilized in Industrial, Scientific and Medical (ISM) applications. A 3-d EM wave simulator, High Frequency Structure Simulator (HFSS) is applied to version the proposed antenna. The substrate cloth used to layout antenna is Rogers Duroid 5880 having dielectric consistent of 2.2. The antenna working parameters consisting of width of patch and duration of patchhave been calculated from the given equations (1& 2) [15].Where c is velocity of light, fo is operating frequency , ∈r is relative permittivity, ∈reff is powerful dielectric constant, μo is permeability of loose space. The different antenna parameters inclusive of extension length (ΔL) and powerful dielectric constant (∈reff)had been evaluated through equations (3 &4)[16]&[17].

$$\Delta L = 0.412h\left[\left(\frac{\epsilon_{reff}+0.3}{\epsilon_{reff}-0.258}\right)\left(\frac{\frac{W_p}{h}+0.264}{\frac{W_p}{h}+0.813}\right)\right] \quad (3)$$

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left(1+\frac{12h}{W_p}\right)^{\frac{-1}{2}} \quad (4)$$

S. No:	Parameters	Symbol	Values
1	Frequency of Operation	f_o	2.4 GHz
2	Width of Patch	W_p	35-45 mm
3	Length of Patch	L_p	36-43 mm
4	Substrate height	h	2mm
5	Substrate width	W_s	45-55 mm
6	Substrate length	L_s	50-60 mm
7	Width of Feed	W_f	5 mm
8	Length of Feed	L_f	15 mm
9	Substrate Material Roger 5880	ϵ_r	2.2
10	Input Impedance	Z_o	50 Ω

TABLE I. DESIGN PARAMETERS

The table I shows the simulation parameters for all the shapes designed here.

B. Flow chart of the simulation desing

Simulation in the HFSS has been carried out through the following steps shown in Fig. 2.

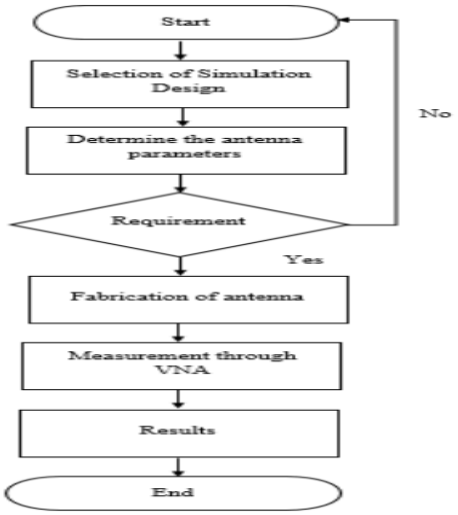


Fig. 2 Flow chart for the simulation

C. Designing Antenna Using HFSS tool

The simulation design of all the antennas is shown in this section. Fig. 3 shows the simulation design of F-shaped antennas, whereas fig. 4, 5, and 6 shows simulation design of T-shaped, E-shaped, and H-shaped antennas respectively.

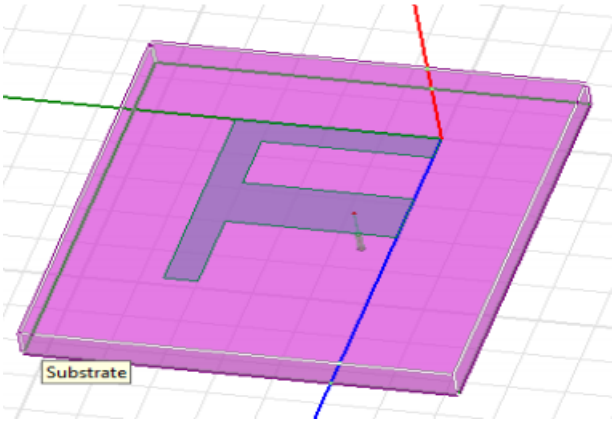
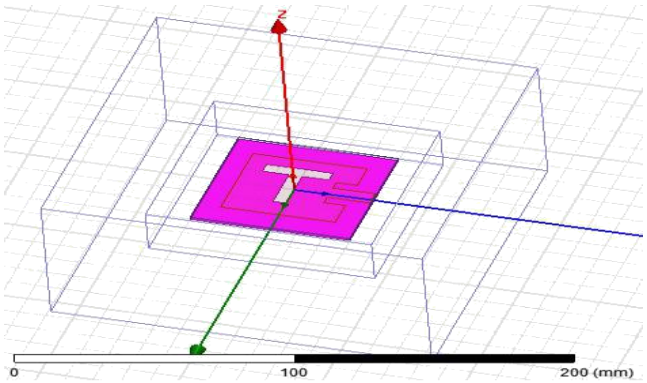


Fig.3 Design of F-Shaped Antenna

Fig. 4 Design of T-Shaped Antenna



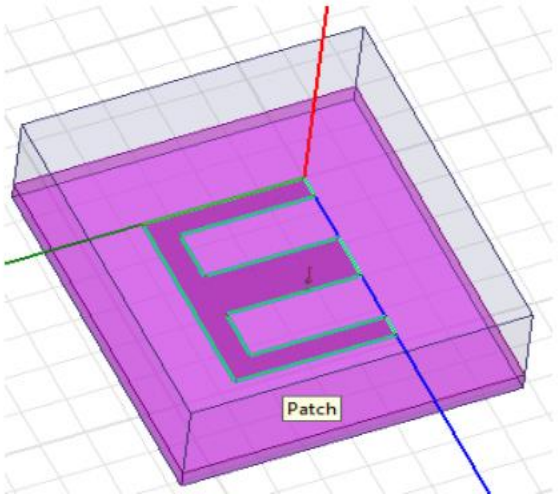


Fig. 5 Design of E-Shaped Antenna

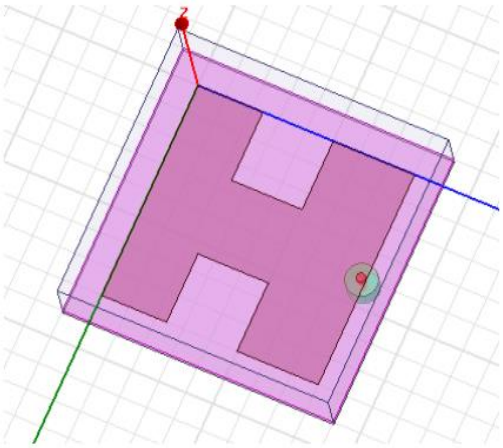


Fig. 6 Design of H-shaped Antenna

3. RESULTS AND DISCUSSION

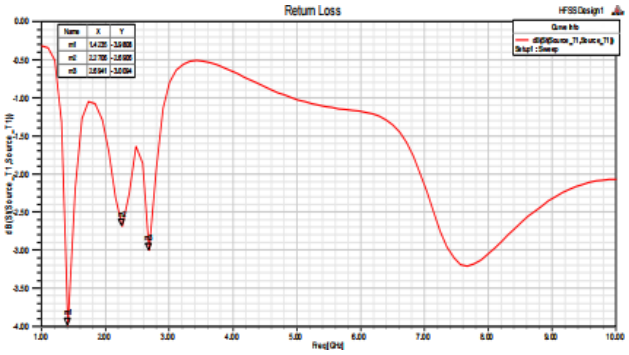


Fig.7 Return loss of F-shaped

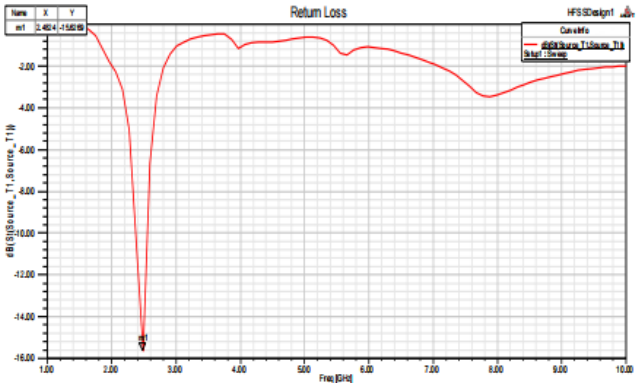


Fig. 8 Return loss of E-shaped

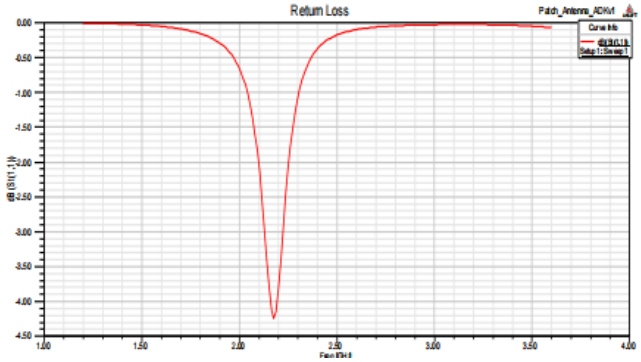


Fig.9 Return loss of T-shaped

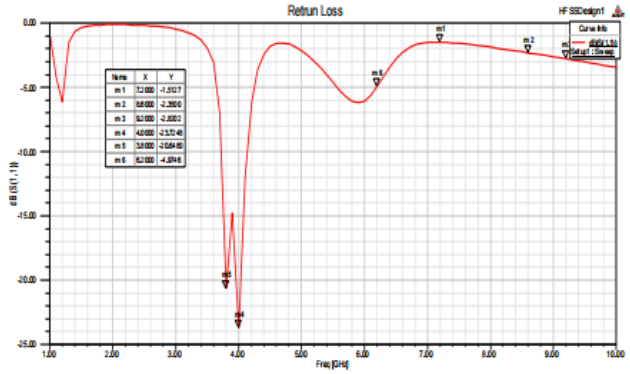


Fig. 10 Return Loss of H-shaped

Fig. (7&8) show the RL plot of the F-shaped and E-shaped

patch antennas. The E-shaped antenna provides RL-value of - 15.67dB at 2.4 GHz, whereas F-Shaped antenna provides RL Value of -4.03dB at 2.4 GHz.

Fig. (9&10) shows the RL plot of T-shaped and H-shaped MPAs. The H-shape of MPA has the return loss of -28.62dB at the frequency of 5GHz.The T-shaped shows RL value of -33.01dB at 1.6 GHz.

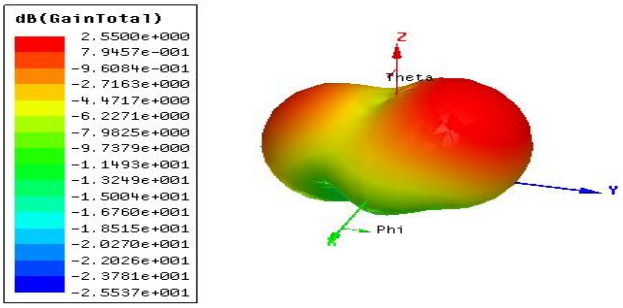


Fig.11 Gain of H-shaped

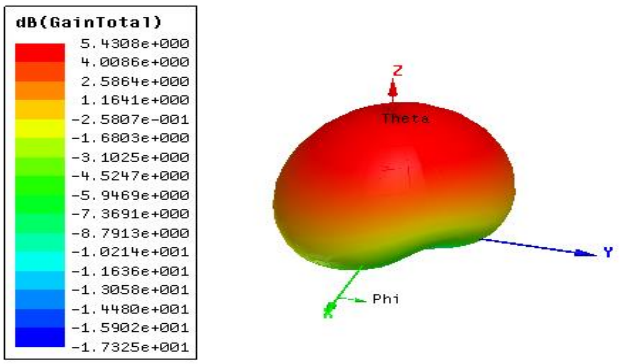


Fig.12 Gain of F-shaped

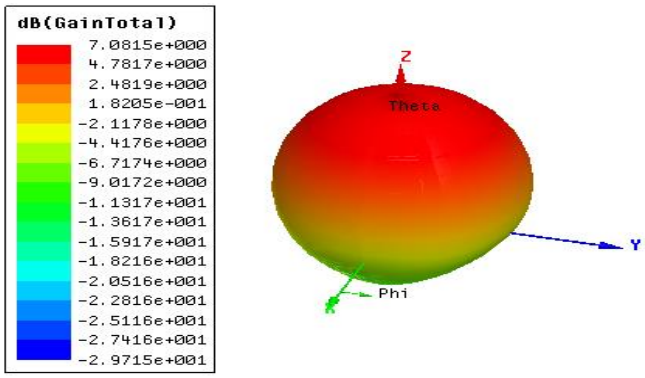


Fig. 13 Gain of T-shaped

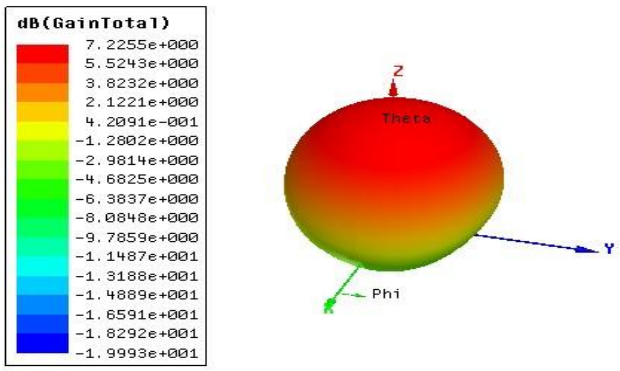


Fig.14 Gain of E-shaped

Fig. (11&13) show the gain of the H-shaped antenna and T□shaped antennas. The H-shaped antenna has gain value of 2.5 dB whereas T-shaped antenna has gain value of 7.0dB. Fig. (12&14) show the gain of the F-shaped antenna and E□shaped antenna. The F-shaped antenna provides gain of 5.43 dB at 2.4 GHz whereas as E-shaped antenna provides gain value of 7.2dB at same frequency range.

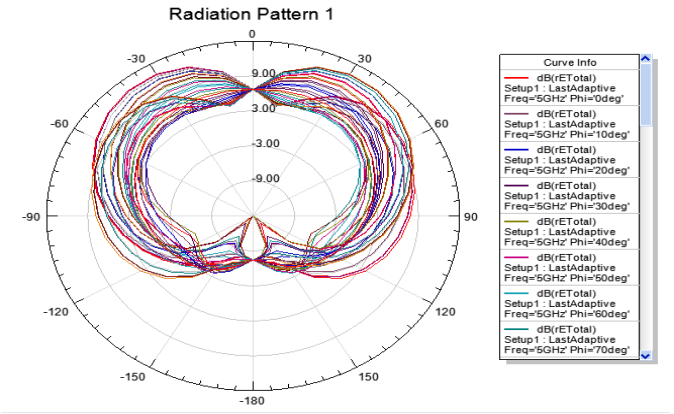


Fig.15 Radiation Pattern of H-shaped

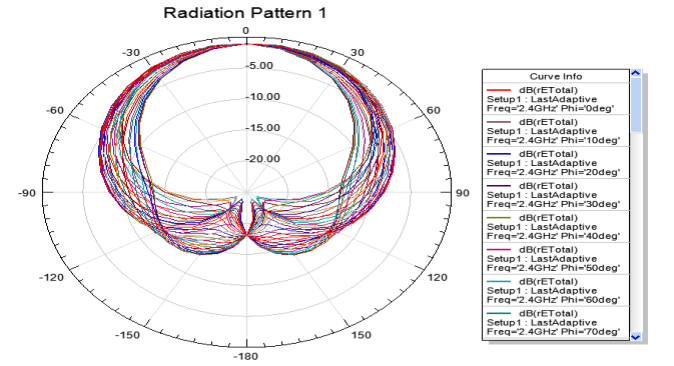


Fig.16 Radiation Pattern of F-shaped

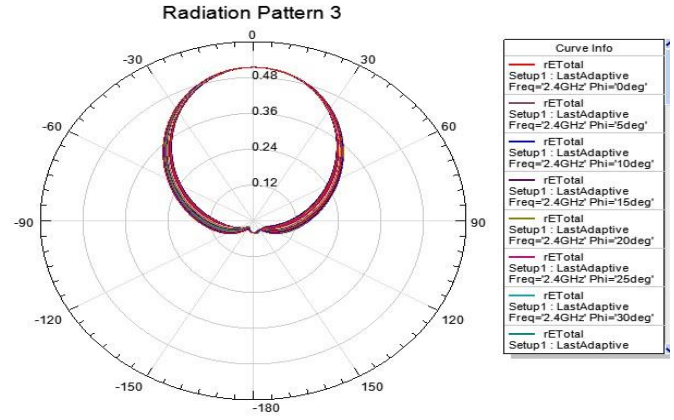


Fig.17 Radiation pattern of T-shaped

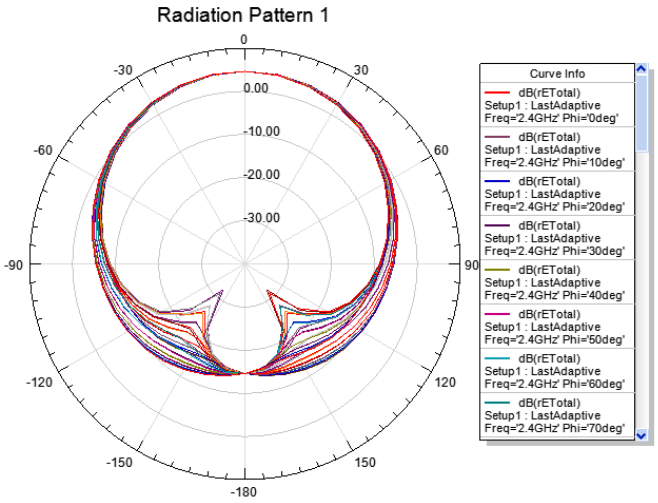


Fig.18 Radiation pattern of E-shaped

The radiation pattern of H and T-shaped antenna is shown in Fig. (15&17). The radiation pattern graph of F and E-shaped antenna is shown in Fig. (16&18).

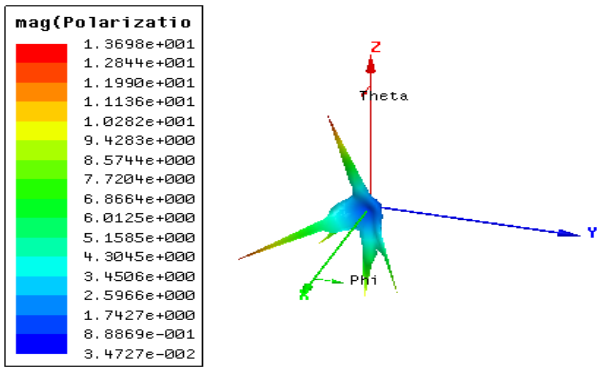


Fig.19 Polarization of H-shaped

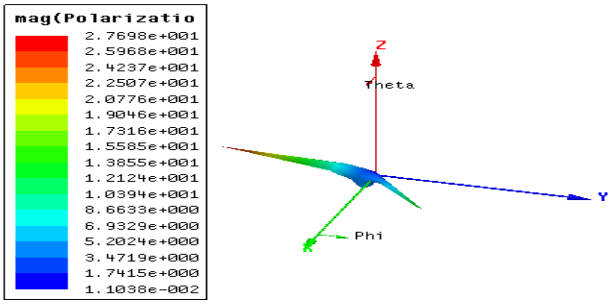


Fig.20 Polarization of F-shaped

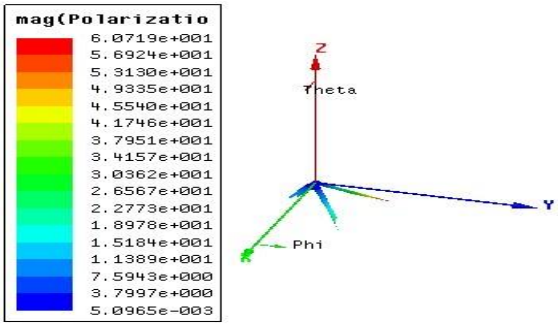


Fig. 21 Polarization of T-shaped

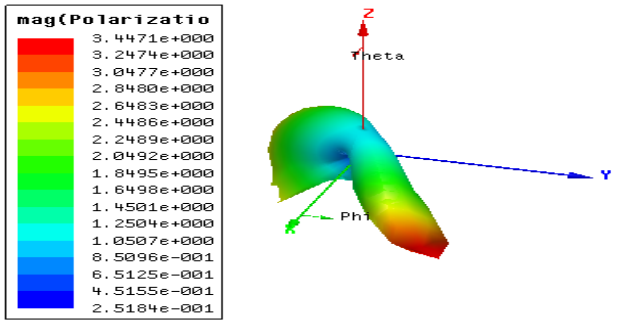


Fig.22 Polarization of E-shaped

Fig. (19& 21) show the polarization plot of H-shaped and T□shaped antenna. Fig.(20&22) show the polarization plot of F-shaped and E□shaped antenna.

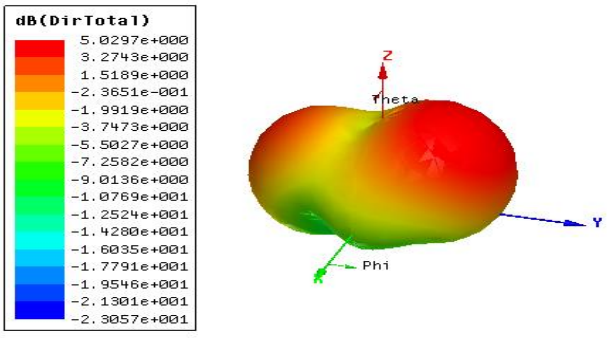


Fig. 23 Directivity of H-shaped

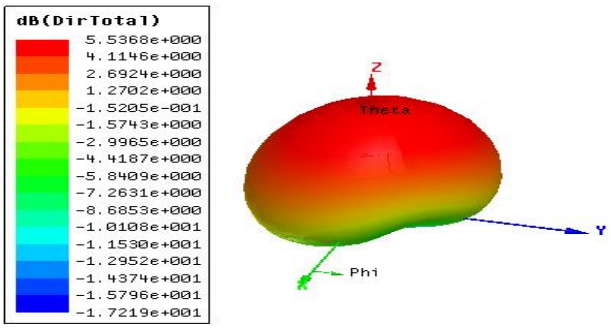


Fig. 24 Directivity of F-shaped

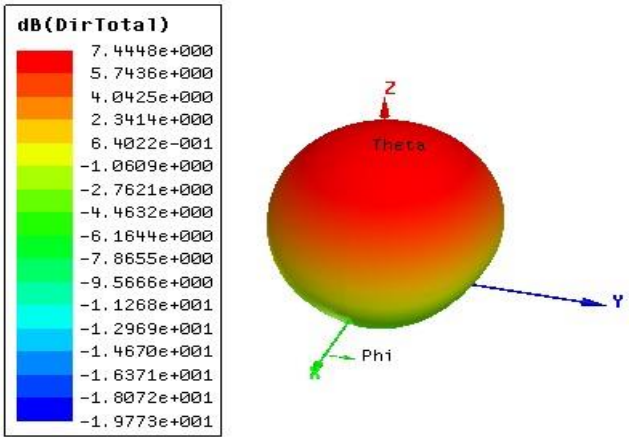


Fig. 25 Directivity of T-shaped

Fig. (23&25) show the directivity graph of H-shaped and T□shaped antennas. The directivity value in X direction of H□shaped antenna is 5.02 dB. Whereas directivity of T-shaped antenna is 7.44d B.

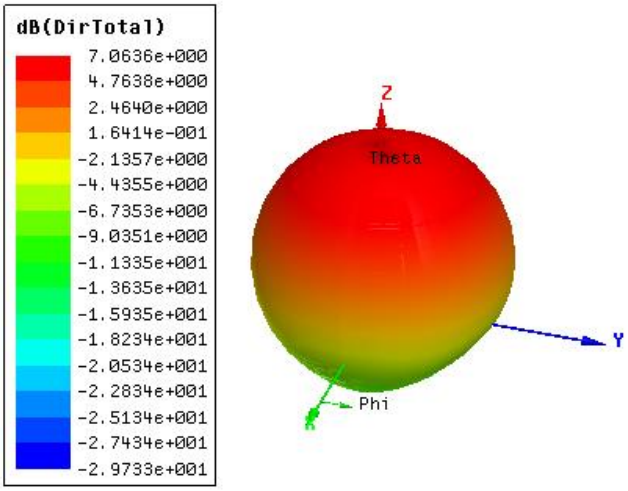


Fig. 26 Directivity of E-shaped antenna

Fig. (24, 26) show the directivity graph of F and E-shaped antennas. The F-shaped antenna has directivity value of 5.5dB in X direction where E-shaped antenna has directivity value of 7.06dB A assessment Table of various shapes of patch antennas is proven in Table II. The assessment of those parameters is performed on the idea their overall performance on one-of-a-kind variety of frequencies. The H-form of MPA has the go back loss of -28.62dB on the frequency of 5GHz. The variant of go back loss as feature of frequency is presented. The antenna benefit is honestly the enter electricity directed especially course withinside the shape of radio waves.The directivity of H-formed antenna is in X-axis course and has numeric fee of 5.02dB.All the shapes show one-of-a-kind houses which may be applied for one-of-a-kind purposes.

Antenna	Gain	Return Loss	Directivity	Polarization
H shaped	2.55 dB	-23.72 dB	5.02 dB	1.36
F shaped	5.43 dB	-3.98 dB	5.4 dB	2.76
T shaped	7.08 dB	-4.3 dB	7.4 dB	6.07
E shaped	7.22 dB	-15.62 dB	7.06 dB	3.44

TABLE II COMPARISON OF DIFFERENT SHAPES OF PATCH ANTENNA

4. CONCLUSION

Different layout strategies of numerous shapes are offered through researchers for distinct variety of programs. We have simulated and offered the performances evaluation of T, H and E-fashioned MPA. The bodily parameters of those four antennas are studied as offered in end result section. These distinct fashioned-antennas produce various traits because the layout parameters are changed. The versions in layout parameters especially have an effect on specially, the gain, RL, and course of strength radiations. Among the examined shapes, we finish that E-fashioned MPA is greater appropriate for the sensible programs. The E-fashioned antenna may be used for any software wherein huge bandwidth is required. Moreover, E- form also can be used for multi-band programs and for length discount of antenna specially for the low frequency antennas under 1 GHz band We have investigated that E-fashioned MPA has higher effects as evaluate to different shapes of MPA, the designed antenna is appropriate for software along with RFID reader and numerous fields. The reconfiguration residences of the proposed antenna can in addition be investigated.

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