PERFORMANCE ANALYSIS OF MICROSTRIP PATCH ANTENNA WITH DIFFERENT SHAPES AND MATERIALS IN C BAND

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ABSTRACT:*The antenna is flexible, robust, light weight and small sized so that it can be used in many places. The Microstrip patch antenna is used to cover various applications such as radar, military, broadcasting, remote sensing and space communication. In this project we have designed different shapes of microstrip patch antenna which are used in the wireless fidelity with a range of frequency of 2.4GHz to 5GHz. We have compared the antenna parameters such as gain, return loss, VSWR of different shapes made of different materials. The antenna is designed with two different materials namely FR-4 and RT - Duroid 5870 material as substrate. The different shapes of the patch designed are T, U and E shapes. The type of feeding technique used is line feeding. The proposed antenna is designed and simulated using HFSS (High Frequency Structural Simulator) software.*

I.INTRODUCTION:

Antennas are key components of any wireless system. An antenna is a device that transmits and/or receives electromagnetic waves. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band that the radio system to which it is connected operates in, otherwise reception and/or transmission will be impaired.

A low-profile antenna, microstrip antenna is a type that can be mounted on a flat ground surface. Over this large flat surface (ground), a rectangular sheet referred as "patch" can be inserted. Commonly, microstrip antenna uses rectangular patch rather than other shapes of patches such as circle, oval, ring, elliptical, helical etc. Rectangular patch provides good transition and is suitable for design that has higher frequencies.

In recent years there is a need for more compact antennas due to rapid decrease in size of personal communication devices. the antenna becomes a significantly larger part of the overall package volume. In addition to this, low profile antenna designs are also important for fixed wireless application. The micro strip antennas used in a wide range of applications from communication systems to satellite and biomedical applications.

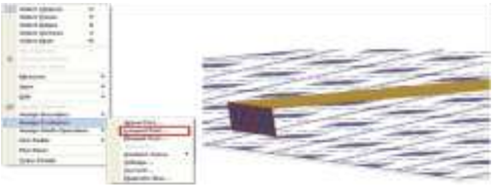
MAIN OBJECTIVE: To analyse the performance of microstrip patch antenna at different frequency in different shapes.

II.PROJECT DESCRIPTION:

A.HFSS:

- HFSS is a commercial finite element method solver for electromagnetic structures from Ansys. The acronym originally stood for high frequency structural simulator. It is one of several commercial tools used for antenna design, and the design of complex RF electronic circuit elements including filters, transmission lines, and packaging.

- In this Project we Designed a 4x1 Microstrip Patch Antenna Array using this tool. With the help of this Tool many Antenna Parameters can be determined such as Return Loss, Gain, VSWR etc...



Lumped port Excitation

Lumped Ports are the other commonly used excitation type in HFSS. This port type is analogous to a current sheet source and can also be used to excite commonly used transmission lines. Lumped ports are also useful to excite voltage gaps or other instances where waveports are not applicable. They should only be applied internally to the solution space. Shown below are examples of commonly used wave ports with proper size dimensions.

DIMENSIONS OF ANTENNA

	FREQUENCY (GHZ)	LENGTH (mm)	WIDTH(mm)	HEIGHT(mm)
FR4	2.4	29.29	37.87	1.6
RTDUR	5	13.75	18.24	1.6
FR4	2.4	40.20	48.40	1.575
RTDUR	5	14.78	23.23	1.575

1 DESIGN OF MPA USING FR-4:

Parameters of model:

Operating frequency (f_0):

The operating frequency band is 2.4Ghz, which is used for Wireless communication such and wifi.

Dielectric constant of the substrate (ε_r)

The dielectric material selected for design is FR-4 epoxy having dielectric constant of 4.4.

Height of dielectric substrate (h)

Height of dielectric substrate h = 1.6 mm

Width calculation (W)

Substituting εr = 4.4 and fo = 2.4 GHz, we get: W = 37.87mm,L= 29.29 mm

Effective dielectric constant calculation (εreff)

Substituting : εr = 4.4, W = 38.04 mm and h = 1 mm, we get : εreff = 4.086

Effective length calculation (Leff)

Substituting : εreff = 3.776, c = 3.0e8 m/s and fo=2.4 GHz

we get: Leff=0.018m = 18 mm

Length extension calculation (ΔL)

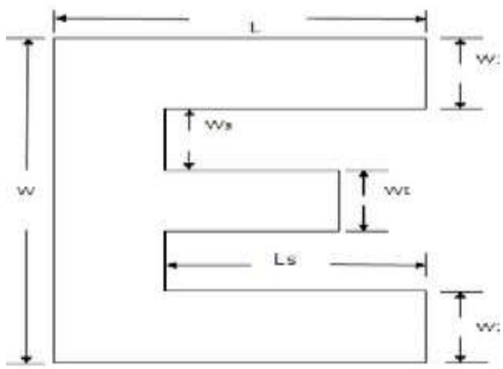
Substituting : εreff =3.776 , W = 28.4 mm and h =1.6 mm we get ΔL =0.9mm

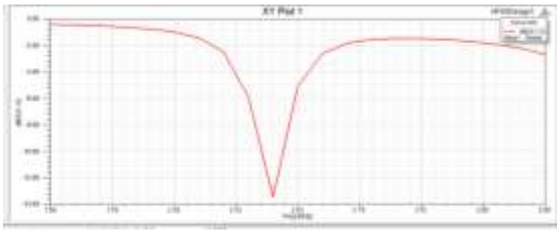
Actual length of patch calculation (L)

L = Leff -2ΔL

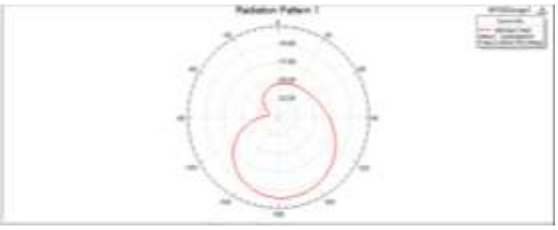
Substituting Leff = 18 mm and ΔL = 0.9 mm we get: L = 38.01mm

E shape antena

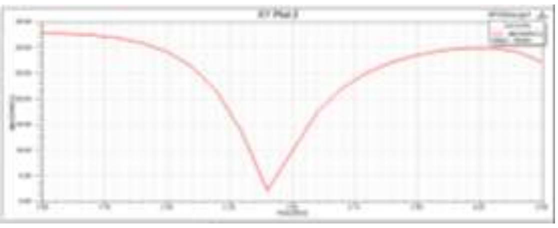




Return loss of E -shape MPA using FR-4 (2.4GHZ)



Radiation pattern of E -shape MPA using FR-4 (2.4GHZ)



Vswr

Parameters of model 2:

Operating frequency (f_0)

The operating frequency band is 5Ghz, which is used for Wireless communication such and wifi.

Dielectric constant of the substrate (ε_r)=4.4.

Height of dielectric substrate (h)=1.6mm.

Width calculation (W)

$$W = \left(\frac{1}{2fr\sqrt{\mu_0\varepsilon_0}}\right)\sqrt{\frac{2}{\varepsilon r+1}}$$

Substituting ε_r = 4.4 and f_o = 5 GHz, we get: **W = 18.24 mm L = 13.75 mm.**

Effective dielectric constant calculation (ε_{reff})

$$\varepsilon_{re_{ff}} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{\omega}\right]^{-\frac{1}{2}}$$

Substituting : ε_r = 4.4, W = 18.24 mm and h = 1 mm, we get : **ε_{reff} = 3.114**

Effective length calculation (L_{eff})

$$L_{eff} = \frac{C}{2fr\sqrt{\varepsilon r_{eff}}}$$

Substituting : ε_{reff} = 3.114, c = 3.0e8 m/s and f_o=5 GHz

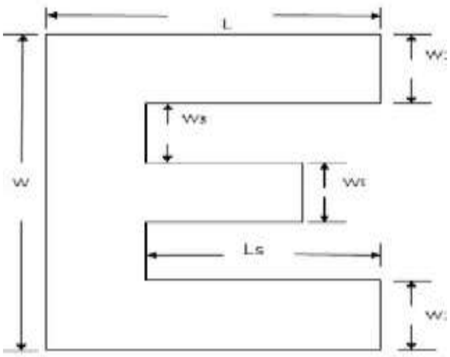
we get: **L_{eff}=0.0017m = 17 mm**

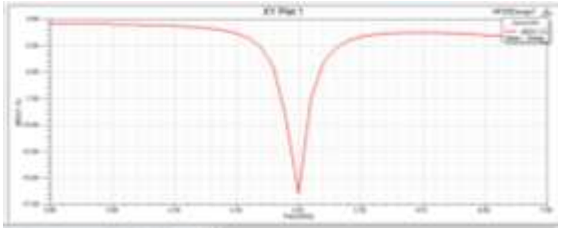
Length extension calculation (ΔL)

$$\Delta L = \frac{0.412h\left[\varepsilon_{re_{ff}}+0.3\right]\left[\frac{W}{h}+0.264\right]}{\left[\varepsilon_{re_{ff}}-0.258\right]\left[\frac{\omega}{h}+0.8\right]}$$

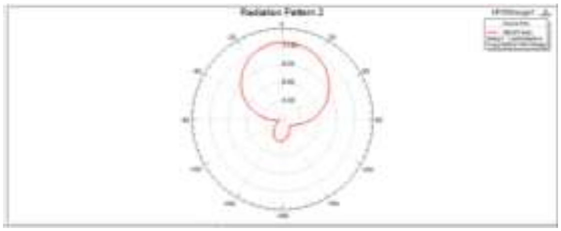
Substituting : ε_{reff} =3.114, W = 18.24 mm and h =1.6 mm we get **ΔL =1.174mm**

E-Shaped patch:





Return loss of E -shape MPA using FR4 (5GHZ)

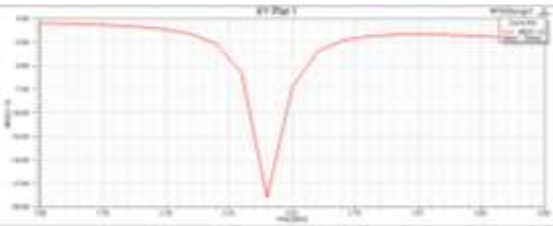


Radiation Pattern of E -shape MPA using FR4 (5GHZ)

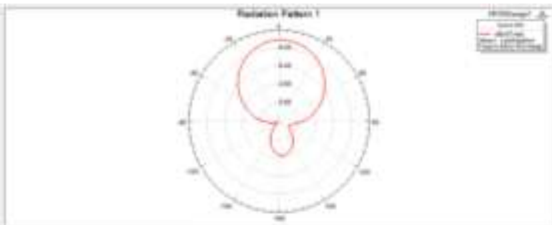
DESIGN OF MPA USING RT duroid:

Operating frequency (f_0)=2.4ghz.

Dielectric constant of the substrate (ε_r)=2.33.
Height of dielectric substrate (h)=1.575mm.

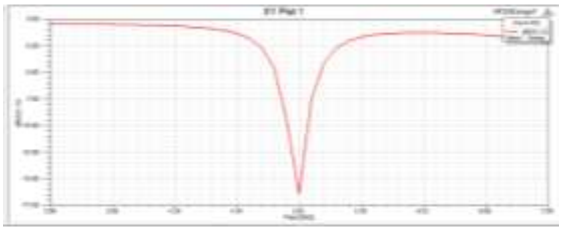


Return loss of E -shape MPA using rt duroid (2.4GHZ)



Radiation pattern of E -shape MPA using rt duroid (2.4GHZ)

Operating frequency (f_0)=5ghz.



Return loss of E -shape MPA using RT duroid(5GHZ)

Radiation pattern of E-shape MPA using RT duriod (5GHZ)

VI. CONCLUSION

The patch antenna with substrate material FR-4 gives better return loss than the patch antenna with substrate material RT-duroid. As also when we change shape of the antenna the gain varies with respect to the dimensions of the patch, substrate and thickness of the antenna. When we compare with frequencies of 2.4GHz and 5Ghz, the antenna that operates on a frequency of 5Ghz in FR-4 material produces a return loss of -17dB. Overall when we compare different shapes of antenna in this type we the E-shape antenna produces the best radiation efficiency and return loss.

VII. REFERENCES

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Computer and Communication Engineering, vol. 3, no. 6, November 2014.

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LITERATURE SURVEY

1 Effect of Substrate relative dielectric constant on Bandwidth characteristics of Line feed Rectangular Patch Antenna Amita Thakur, Manoj Chauhan and Mithilesh Kumar in the International Journal of Engineering Science Invention Research & Development on Vol. I Issue X April 2015 designed and implemented rectangular microstrip patch antenna for different types of substrate material. By care full observation of paper we can conclude that when we increasing the substrate dielectric constant in antenna design The performance characteristics of antenna like antenna bandwidth , gain and S11(Return loss) parameter are degraded.

2. Comparison of Circular Sector and Rectangular Patch Antenna Arrays in C-Band Anouar Dalli, Lahbib Zenkouar, Seddik Bri in the Journal of Electromagnetic Analysis and Applications, 2012, April The gain of patch antenna was improved for both shapes using array techniques (10 dB for 4 elements) and (14 dB for 10 elements). From comparison with literature [14-16], we proved the ability of using circular sector patch antenna array with same performance of rectangu-lar patch with interesting dimension and circular polari-zation.

3. Designing and Analysis of T-Shape Microstrip Antenna for the 4G Systems " by Amit Kumar & Sanjay Singhin in 2012, the designing and analysis of T-shape microstrip patch antenna is presented. The shape will provide the broad bandwidth which is required for the operation of fourth generation wireless systems. The operating frequency of antenna is 2.5 GHz, the dielectric constant and thickness of the antenna is 4.2, 1.6mm respectively. This antenna is fed by a co-axial probe feeding. In this paper, the effects of different types of antenna parameters like return loss, voltage standing wave ratio (VSWR), impedance etc. are also studied.

4 Comparison of different shapes in microstrip patch antenna for X-band application R.Kiruthika and T.Shanmuganantham in 2016 , In this paper, conventional shapes like Rectangular, Triangular and Circular Microstrip patch antenna are designed and analyzed. The antenna is designed to resonate at X-band frequency. The X-band frequency range lies between 8 to 12 Gigahertz and are widely used in radar applications. The substrate used by the antenna is the low cost FR4 (Flame Retardant) Epoxy. The Ansoft HFSS (High Frequency Structural Simulator) Version 12 software is used to analyze the results of different shapes of Microstrip patch antenna. The parameters like return loss, bandwidth, gain and directivity are compared and discussed in this paper.

5. Performance Analysis of Different Shapes Patch Antennas At 2.45 Ghz.
Ms. Rakhi and Ms.Sonam Thakur , The area of microstrip antennas is one of the most dynamic fields of antenna theory and has seen some inventive work in recent years. The increasing need for mobile communication and the

emergence of newer technologies require an efficient design of antenna of smaller size for wider frequency range applications such as Wi-Max. In this work, different geometry shapes, the E-shape and U-slot are developed from a rectangular patch of the width (W) = 39 mm and length (L) = 29 mm at a frequency of 2.45 GHz VSWR have been investigated. The substrate material used for the proposed antennas is FR-4 lossy with the dielectric constant of 4.1.

6 Analysis and Design of Rectangular Microstrip Patch Antenna Using HFSS by P.Kokila, T.Saranya, T.Saranya in the Journal of Network Communications and Emerging Technologies (JNCET) Volume 6, Issue 4, April (2016) In this paper we observed that the microstrip antenna, types of microstrip antenna, feeding techniques and application of microstrip patch antenna with their advantage and disadvantages over conventional microwave antennas.