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Design Analysis Of Microstrip Patch Antenna For Rectangular And Circular Patches

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Abstract—**Modern Wireless communication Systems require low profile, lightweight, high gain and simple structure antennas to assure reliability, mobility, and high efficiency. A patch antenna is very simple in construction using a conventional microstrip fabrication technique. It consists of a patch of metallization on a grounded dielectric substrate. They are low profile, lightweight antennas, most suitable for aerospace and mobile applications. Patch antennas have matured considerably during last years, and many of their limitations have been overcome. The conducting patch can take any shape, but rectangular configurations are the most commonly used. In our study we are interested in rectangular and circular patch antenna designs.**

The objective of this research is to analysis the results of different patches for different dielectric constants as 2.2, 4.4, 9.8.

Index Terms—**matlab tool, patch antenna.**

I. Introduction

In desiging the microstrip patch antenna many parameters are
Important. Dielectric substrate is the main parameter in design purpose. Main purpose of this is to analysis the radiation pattern of rectangular and circular microstrip patch antenna for different dielectric substrates and comparison of these results. Matlab is the basic tool for design purpose.

II. Procedure

A. Simulation results of rectangular microstrip patch antenna for different dielectric substrates.

B. Simulation results of circular microstrp patch antenna For different dielectric substrates

C. Comparison results of rectangular and circular microstrip patch antenna

III. Analysis of Rectangular Microstrip Patch Antenna at 2.2,4.4,9.8 Dielectric Substrates.

Analysis of rectangular patch at 2.2 dielectric substrate
At Frequency 2GHz for the dielectric constant 2.2 radiation pattern has been analysed. From this analysis calculated gain is 20.9852db. Radiation polar plot for electric & magnetic field displayed in Fig 1.1

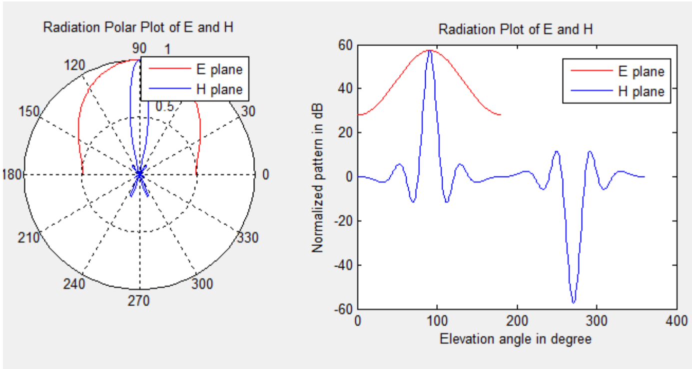

Fig 1.1 Radiation Pattern of Microstrip Antenna At 2.2 Dielectric Constant

Observe the E and H planes for 2.2 dielectric substrates For Rectangular Patch

A. Input parameters

Resonant frequency(Ghz)	2.0
Dielectric constant	2.2
Height of substrate(cm)	.157
Position of recessecd feed point(cm)	2.630

B. Output parameters

Physical width of patch(cm)	5.9293
Effective length of patch(cm)	5.1478
Physical length of patch(cm)	4.9820
E plane HPBW(degrees)	92
H plane HPBW(degrees)	76
Directivity of rectangular patch	5.1984

Simulation results of E and H planes at 2.2 dielectric constant

At 2 ghz frequency and 2.2 dielectric constant calculated value of directvity is 7.1587 dB E plane hpbw is 92.00 and H plane hpbw is76.00 in degree is calculated form the Fig 1.2 and 1.3

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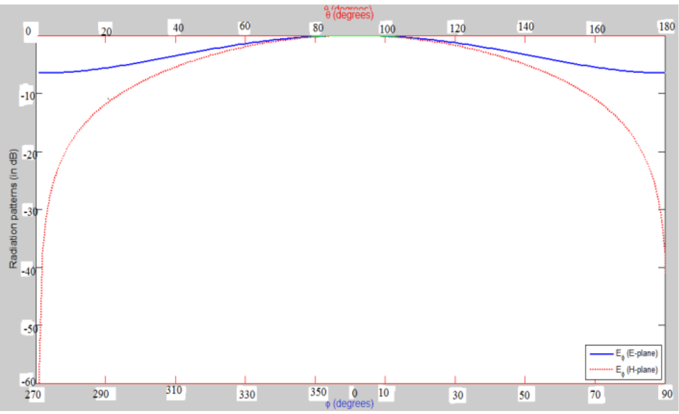

Figure 1.2 Radiation Pattern vs φ (degree)

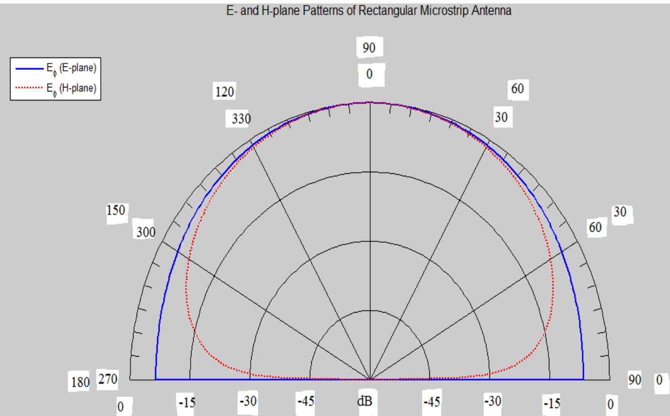

Figure 1.3 Calculation Of Half Power Beamwidth

SIMULATION AT DIELECTRIC CONSTANT 4.4

At Frequency 2GHz for the dielectric constant 4.4 radiation pattern is analysed.From this analysis calculated gain is 18.3636db. Radiation polar plot for electric & magnetic field displayed in Figure1.4

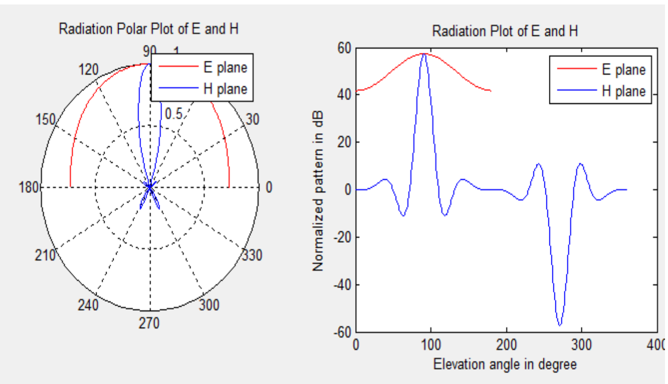

Fig 4.4 Radiation Pattern of Microstrip Antenna At 4.4 Dielectric Constant

Observe the E and H planes for 4.4 dielectric substrates For Rectangular Patch

A. Input parameters

Resonant frequency(Ghz)	2.0
Dielectric constant	4.4
Height of substrate(cm)	.157
Position of recessecd feed point(cm)	2.3700

B. Output parameters

Physical width of patch(cm)	4.5644
Effective length of patch(cm)	3.6904
Physical length of patch(cm)	3.54450
E plane HPBW(degrees)	180
H plane HPBW(degrees)	80
Directivity of rectangular patch	4.0024

Simulation results for E & H Planes at 4.4 dielectric constant

At 2 GHz frequency and 4.4 dielectric constant calculated value of directvity is 6.0232 dB. E plane HPBW is 180.00 and H plane HPBW is 80.00 in degree is calculated from Fig 1.5 & 1.6.

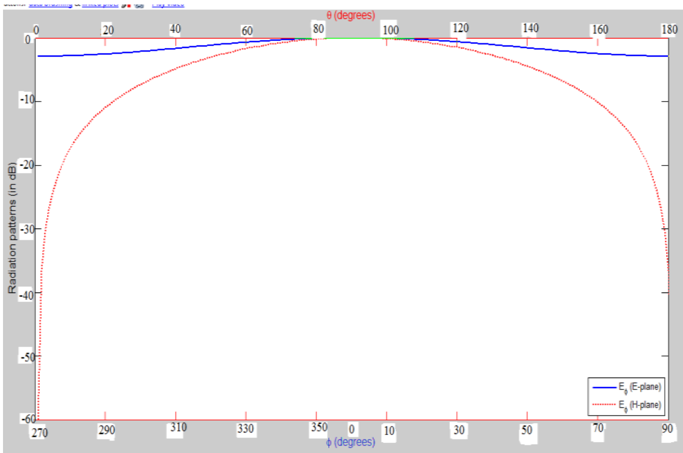

Figure 1.5 Radiation Pattern vs φ (degree)

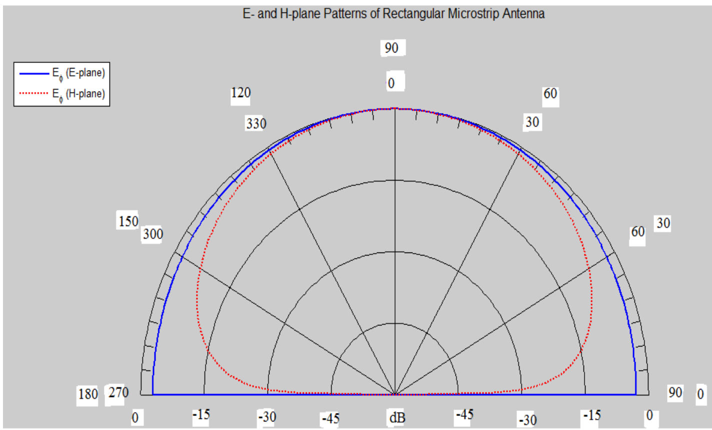

Figure 1.6 Calculation Of Half Power Beamwidth

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4.1.3 SIMULATION AT DIELECTRIC CONSTANT 9.8

At Frequency 2GHz for the dielectric constant 9.8 radiation pattern is analysed.From this analysis calculated gain is 15.96 db. Radiation polar plot for electric & magnetic field displayed in Fig 1.7.

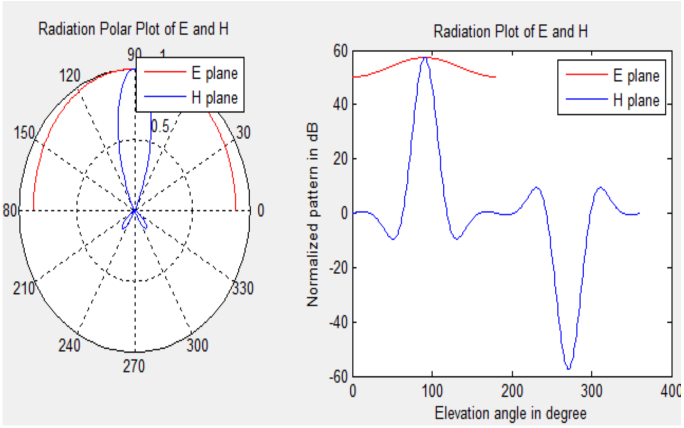

Fig 1.7 Radiation Pattern of Microstrip Antenna At 9.8 Dielectric Constant

Observe the E and H planes for 9.8 dielectric substrates For Rectangular Patch

A. Input parameters

Resonant frequency(Ghz)	2.0
Dielectric constant	9.8
Height of substrate(cm)	.157
Position of recessecd feed point(cm)	1.6130

B. Output parameters

Physical width of patch(cm)	3.2275
Effective length of patch(cm)	2.5145
Physical length of patch(cm)	2.3803
E plane HPBW(degrees)	180
H plane HPBW(degrees)	84
Directivity of rectangular patch	3.4172

Simulation results for E & H Planes at 9.8 dielectric constant

At 2 GHz frequency and 9.8 dielectric constant calculated value of directvity is 5.3367 dB. E plane HPBW is 180.00 and H plane HPBW is 84.00 in degree is calculated from Figure 1.8 & 1.9

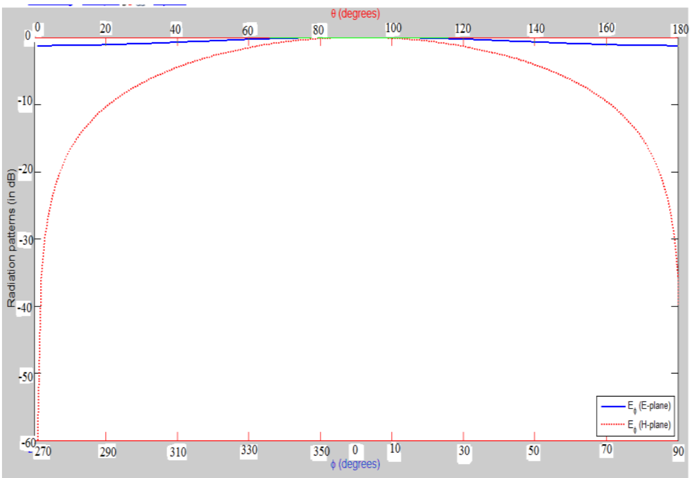

Fig 1.8 Radiation Pattern vs φ (degree)

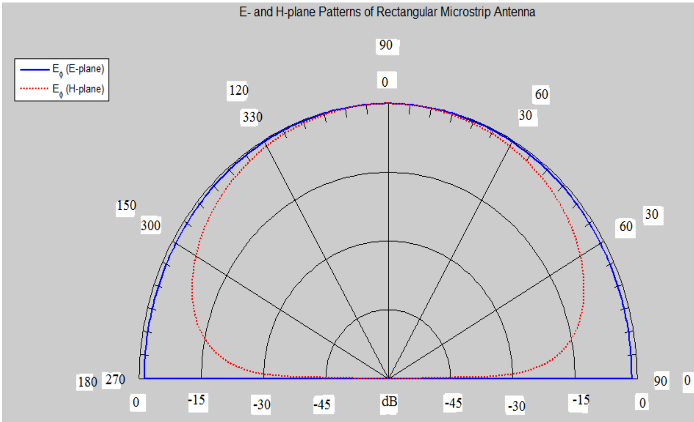

Fig 1.9 Calculation Of Half Power Beamwidth

4.2 SIMULATION RESULTS OF CIRCULAR MICROSTRIP PATCH FOR DIFFERENT DIELECTRIC SUBSTRATES

4.2.1 Simulation at dielectric constant 2.2

At Frequency 2GHz for the dielectric constant 2.2 radiation pattern has been analysed. From this analysis calculated gain is 20.545 db. Radiation polar plot for electric & magnetic field displayed in Figure 2.0

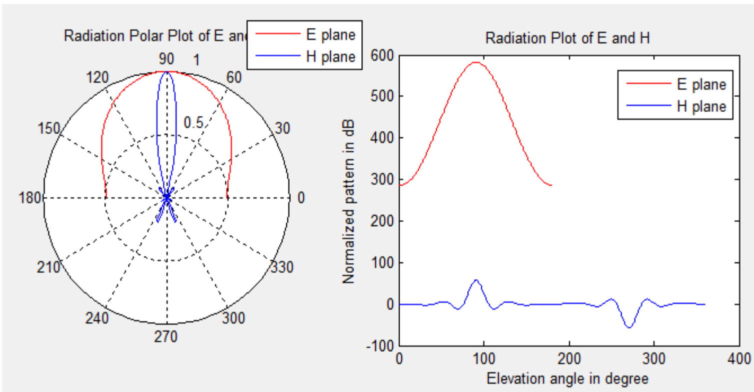

Fig 2.0 Radiation Pattern Of Microstrip Antenna At 2.2 Dielectric Constant

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Observe the E and H planes for different dielectric substrates For circular Patch

A.Input parameters

Resonant frequency(Ghz) 2.000
Dielectric constant 2.200
Height of substrate(cm) .1570

B.Output parameters

Physical radius of patch(cm) 2.8527
Effective radius of patch(cm) 2.9668
E-PLANE HPBW (in degrees) 92
H-PLANE HPBW (in degrees) 78
Directivity of circular patch 5.4719

Simulation results of E and H planes at 2.2 dielectric constant

At 2 GHz frequency and 2.2 dielectric constant calculated value of directvity is 7.3814 dB E plane hpbw is 92.00 and H plane hpbw is78.00 in degree is calculated form the Fig 2.1 and 2.2

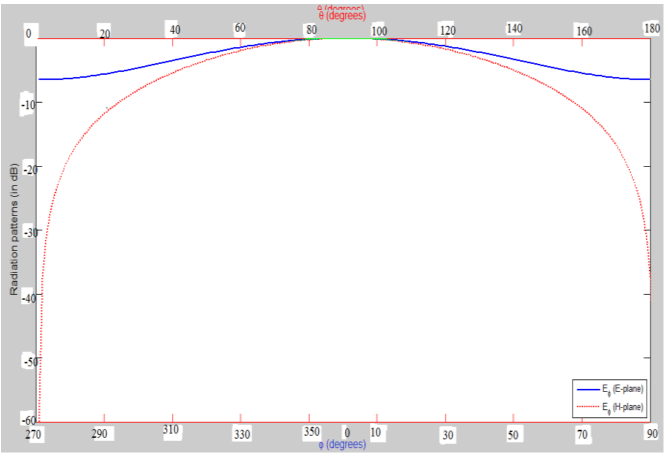

Fig 2.1 Radiation Pattern vs φ (degree)

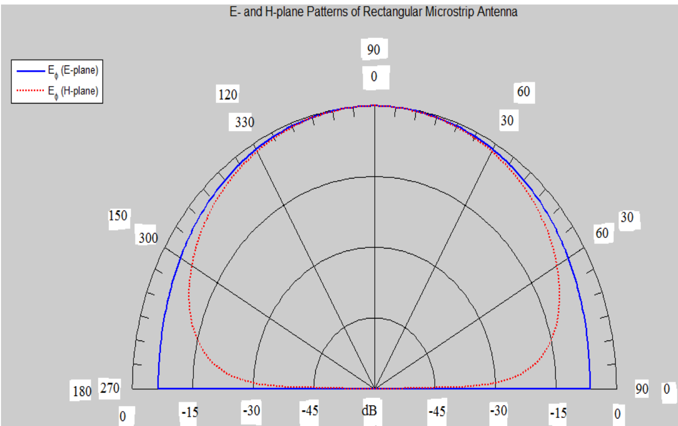

Fig 2.2 Calculation Of Half Power Beamwidth

4.2.2 SIMULATION AT DIELECTRIC CONSTANT 4.4

At Frequency 2GHz for the dielectric constant 4.4 radiation pattern is analysed.From this analysis calculated gain is 18.3139 db. Radiation polar plot for electric & magnetic field displayed in Fig 2.3.

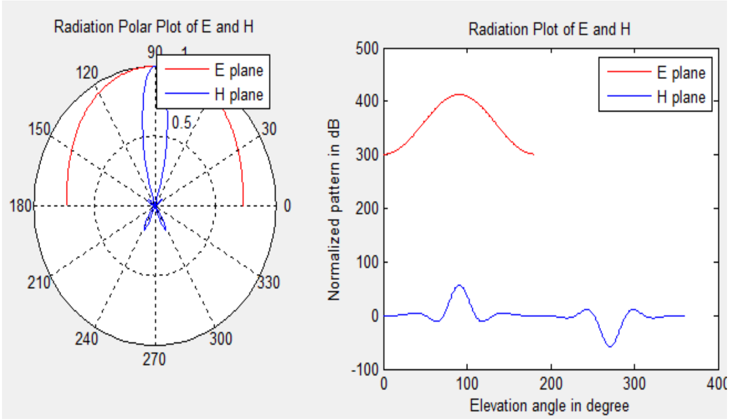

Fig 2.3 Radiation Pattern Of Microstrip Antenna At 4.4 Dielectric Constant

Observe the E and H planes for different dielectric substrates For circular Patch

A.Input parameters

Resonant frequency(Ghz) 2.000
Dielectric constant 4.4
Height of substrate(cm) .1570

B.Output parameters

Physical radius of patch(cm) 2.0428
Effective radius of patch(cm) 2.0965
E-PLANE HPBW (in degrees) 180
H-PLANE HPBW (in degrees) 84
Directivity of circular patch 4.0471

b .Simulation results of E and H planes at 4.4 dielectric constant

At 2 GHz frequency and 4.4 dielectric constant calculated value of directvity is 6.0715 dB E plane hpbw is 180.00 and H plane hpbw is 84.00 in degree is calculated form the Fig 2.4 and 2.5

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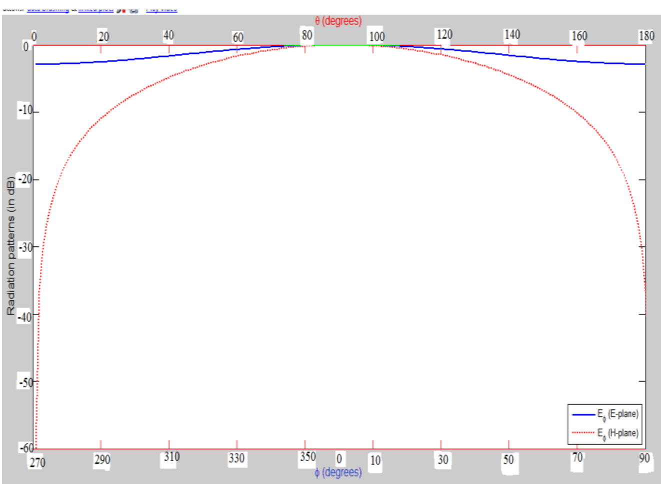

Fig 2.4 Radiation Pattern vs φ (degree)

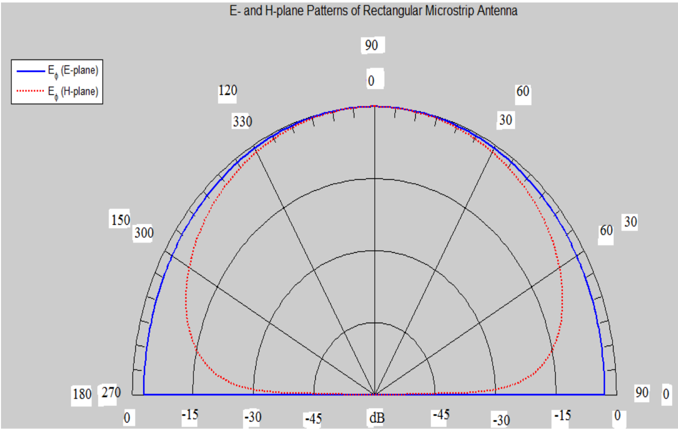

Fig 2.5 Calculation Of Half Power Beamwidth

4.2.4 MATLAB SIMULATION AT DIELECTRIC CONSTANT 9.8

At Frequency 2GHz for the dielectric constant 9.8 radiation pattern has been analysed. From this analysis calculated gain is 15.8094 db. Radiation polar plot for electric & magnetic field displayed in Fig 2.6.

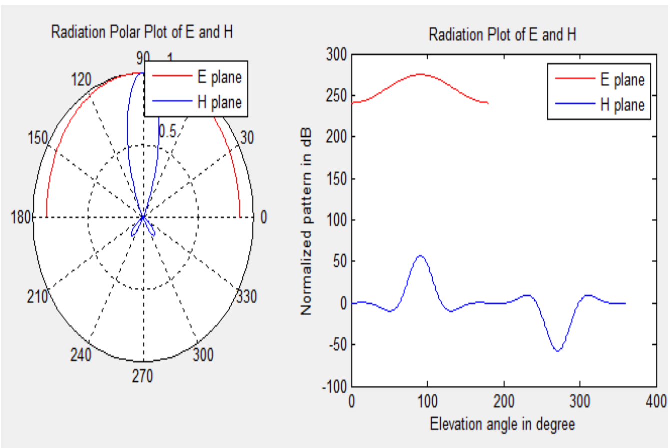

Fig 2.6 Radiation Pattern Of Microstrip Antenna At 9.8 Dielectric

Observe the E and H planes for different dielectric substrates For circular Patch

A.Input parameters

Resonant frequency(Ghz)	2.000
Dielectric constant	9.8
Height of substrate(cm)	.1570

B.Output parameters

Physical radius of patch(cm)	1.3821
Effective radius of patch(cm)	1.4044
E-PLANE HPBW (in degrees)	180
H-PLANE HPBW (in degrees)	86
Directivity of circular patch	3.4123

c .Simulation results of E and H planes at 9.8 dielectric constant

At 2 GHz frequency and 4.4 dielectric constant calculated value of directvity is 5.3305 dB E plane hpbw is 180.00 and H plane hpbw is 86.00 in degree is calculated form the Fig 2.7and 2.8

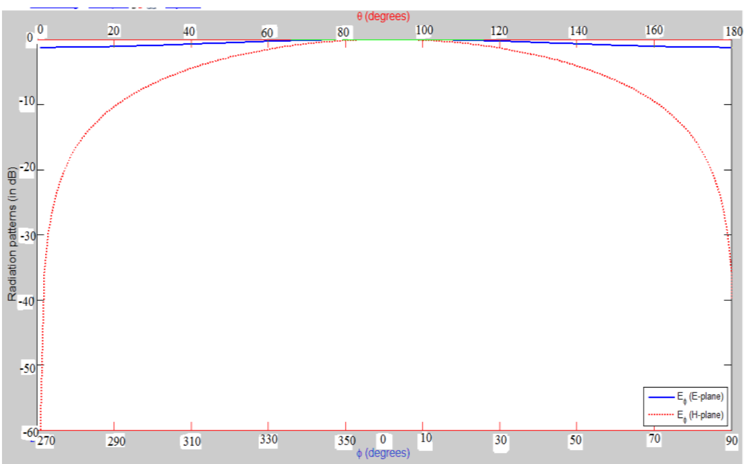

Fig 2.6 Radiation Pattern vs φ (degree)

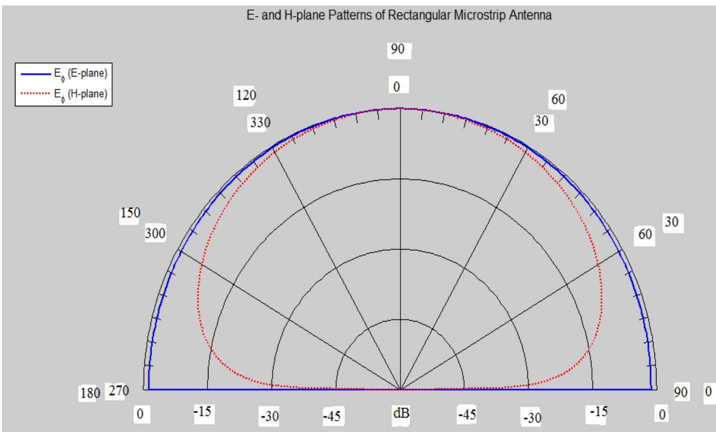

Fig 2.7 Calculation Of Half Power Beamwidth

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LITRATURE SURVEY

"Sumita Shekhawat, Pratibha Sekra,Deepak Bhatnagar, *Senior Member, IEEE*, Virender Kumar Saxena, and Jaswant Singh Saini (2010)". Design and analysis of a single-feed arrangement of stacked rectangular patches is proposed, which is capable of providing circular polarization along with broadband performance.An antenna is designed on a glass epoxy FR-4 substrate with overall thickness of the structure less than 8mmor 0.11.

This technological trend has focused much effort on the design of a Microstrip patch antenna, by K.O. Odeyemi; D.O. Akande2 and E.O. Ogunti;" (2012)" the pattern of two designs of a Microstrip patch antenna have been analyzed and studied.

Md. Maruf Ahamed; Kishore Bhowmik; Abdulla Al Suman; (2012)" presents the result for different resonant frequencies and the result is performed by thickness of 2.88mm and Duroid substrate with dielectric constant of 2.32, L- band frequency 2GHz are gives the best result.

T.Durga; Prasad; K.V.S.Kumar; MD Khwaza Muinuddin; Chisti B.Kanthama, V.Santosh Kumar P.Raju;(2011), the pattern of two designs of a Microstrip patch antenna have been analyzed and studied [4]. A rigorous analysis of the problem begins with the application of the equivalence principle that introduces the unknown electric and magnetic surface current densities on the dielectric surface.

Md. Maruf Ahamed; Kishore Bhowmik; Md. Shahidulla;Md. Shihabul Islam, Md.Abdur Rahman;(2012) the result for different dielectric constant values and the result is performed by thickness of 2.88mm and resonance frequency of 2GHz where 2.32 (Duroid) are gives the best result.. This technological trend has focused much effort into the design of a Microstrip patch antenna.

Neha Ahuja, Rajesh Khanna, Jaswinder Kaur (2012) A microstrip patch antenna for Wi-Max and GSM application is proposed. The antenna has a frequency bandwidth of 1.24 GHz (4.6053 GHz – 5.8481 GHz) for WLAN and Wi-Max and 1.04 GHz (6.124 GHz – 7.16 GHz) for Satellite application. The microstrip antenna has a planar geometry and consists of a defected ground, a substrate, a patch, a feed, one slot in patch and a defected ground which consists of a pie slot and reduced area from all three sides except the feed side.

CONCLUSION & FUTURE SCOPE

CONCLUSION

This letter presents the design and performance of a rectangular & circular patches on three dielectric substrates. The designed antenna presents much improved impedance and directivity and larger gain. These improved parameters are achieved without much increase in the thickness of the structure. The significant improvement in the directivity, HPBW is the main achievement of the proposed work. In several modern-day wireless and satellite communication systems, circularly polarized radiations with higher axial ratio bandwidth are desired, and this antenna may prove to be a useful structure for these systems.

In the previous chapter calculation of half power beam width ,directivity ,gain has been done.In reference paper the input frequency is 4.6 ghz,dielectric constant is 4.4 ghz. All the simulation was done with ie3d software. Main concern of this project is to design parameters of rectangular patch and circular patch using matlab software. All the calculations are done using 4.6 ghz frequency for rectangular and circular patch. We have also used another frequency 2 ghz for calculation of parameters of rectangular and circular patches.

From the above tables we conclude that circular patch antenna is more effective than rectangular patch in terms of radiation pattern and directivity .for calculating these parameters three types of substrates are used, from these results we conclude that as the value of dielectric constant increases the gain, directivity of antenna decreases. So for getting better results the value of dielectric constant should be low.circular patch is always useful for all the application where compact antennas are required.it should be light weight and should have circular polarization. This antenna is always useful in several wireless and satellite applications.

FUTURE SCOPE

From the Equation of the Rectangular manual calculation of all parameter is complex. By the use of the GUI this can be easy to calculate it. The Effect of the Changes in input parameter on radiation pattern can be easily analyzed by the use of GUI. As mentioned in results by changes in the material of the patch physical parameter of the Microstrip Patch is changes, this will be help designer to determine the antenna performance and make necessary adjustment before fabrication.

In thesis different dielectric constants are used for a single frequency operation. By keeping the frequency constant calculation of gain, directivity, HPBW, char. Impedance, is done.

A further study can be look into the design of a microstrip patch antenna array operating at UHF frequency. This will further improved the antenna with very directive characteristics or very high gains to meet the demands for long distance communication as well as providing a fixed beam of specified shape (shape beam) or a beam that scans in response to system stimulus. One of the applications is to use a UHF microstrip antenna array for Synthetic Aperture radar onboard an aerial platform

Using Matlab for antenna design simulation is very challenging as it will take very complex programming to achieve the desire results and it is very time consuming. However, this can be easily solved by using RF simulation software like Zealand IE3D. If future work is to be carried out, it is recommended to use this advance software for the initial design and simulation and should there be facilities

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available, ie microwave anechoic chamber, hardware implementation and testing should be carried out.

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