DESIGN OF COMPACT MICROSTRIP PATCH ANTENNAS

A Major thesis submitted to Faculty of technology

Of

University of Delhi

Towards the partial fulfillment of the requirement

For

The award of the Degree

Master of Engineering

In

Electronics & Communication

Submitted by

Sachin Tyagi

Under the guidance of

Prof. Asok De

Head IT Deptt.

DEPARTMENT OF ELECTRONICS AND

COMMUNICATION ENGINEERING

DELHI COLLEGE OF ENGINEERING

UNIVERSITY OF DELHI

DELHI-110042

CERTIFICATE

This to certify that the work entitled "Design of compact Patch Microstrip Antennas" has been carried out by Sachin Tyagi under my supervision in partial fulfillment of the requirement for the degree of master of Technology in Electronics and Communication Engineering of University of Delhi,Delhi,during the session 2003-2005 at Delhi College of Engineering,Delhi.

Prof. Asok De
Head
Department of Information Technology
Delhi College of Engineering
Delhi

ACKNOWLEDGEMENT

It is my pleasure to acknowledge and express my deep sense of gratitude towards my teacher and guide, **Prof. Asok De**,Professor and Head,Department of Information Technology,Delhi College of Engineering,who supervised the work reported in this major thesis report.He was always kind,cooperative and helped me whenever I needed.Inspite of their busy schedule,he could find time to provide precious guidance and encouragement.

Finally I thank everyone who has helped me either directly or indirectly in the successful completion of this work.

Sachin Tyagi

20/EC/03

Univ. Roll No.:3106

ABSTRACT

The concept of microstrip radiators was proposed in 1953.However, 20 years passed before practical antennas were fabricated. Development during the 1970s was accelerated by the availability of good substrates with low loss tangent and attractive thermal and mechanical properties, improved photolithographic techniques, and better theoretical models. Since then, extensive research and development of microstrips antennas and arrays ,aimed at exploiting their numerous advantages such as light weight, low volume, low cost, conformal configuration, compatibility with integrated circuits, and so on, have to diversified applications and to the establishment of the topic as the separate entity with in the broad field of microwave antennas.

The paper used for implementation presents a novel design of triangular microstrip antenna with dual frequency operation. In this design the microstrip patch is short circuited using a shorting pin & fed by a single probe feed. By varying the shorting pin position in the microstrip patch, such a design can provide a large tunable frequency ratio of about 2.5-4.9 for the two operating frequencies. Experimental results are presented & discussed.

Contents

CHAPTER – 1

INTRODUCTION

INTRODUCTION

1.1 Antenna: An Antenna may be a single straight wire or a conducting loop excited by a voltage source, an aperture at the end of waveguide, or a complex array of these properly arranged radiating elements.

1.2 Radiation Pattern: The graph that describes the relative far-zone field strength versus direction at a fixed distance from an antenna is called the radiation pattern of the antenna, or simply the antenna pattern.

In general, an antenna pattern is a three dimensional, varying with both theta & phi in a spherical co-ordinate system. The difficulties of making three-dimensional plots can be avoided b plotting separately the magnitude of the normalized field strength(with respect to peak value)versus theta for a constant phi (an E-plane pattern)& the magnitude of the normalized field strength versus phi for theta =90 degree(the H-plane pattern).

1.3 Radiation intensity: It is the time average power per unit solid angle.

1.4 Beamwidth : The main-beam beamwidth describes the sharpness of the main radiation region. It is generally taken to be the angular width of the pattern between the half power points, or –3(db) points.

1.5 Directivity: A commonly used parameter to measure the overall ability of an antenna to direct radiated power in a given direction is called directive gain and the maximum directive gain of an antenna is called the directivity of the antenna. 1<**D**<infinity, for isotropic antenna D=1

1.6 Power Gain or simply Gain : The power gain or simply gain **Gp**, of an antenna referred to an isotropic source is the ratio of its maximum radiation intensity to the radiation intensity of a lossless isotropic source with the same power input.

$$G_p = (4Pi\ U_{max}) / (P_{input})$$

1.7 Radiation Efficiency: The ratio of the gain to the directivity of an antenna is called the radiation efficiency, **n**.

$$n = Gp / D$$

CHAPTER 2

THEORY OF TRIANGULAR PATCH ANTENNA

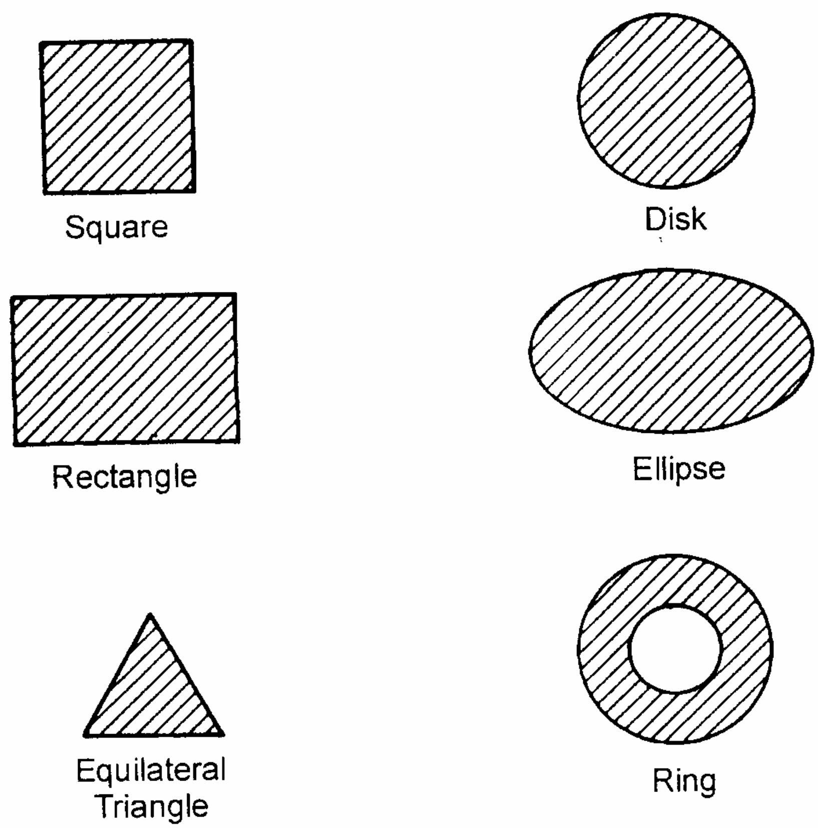
THEORY OF TRIANGULAR PATCH ANTENNA

Microstrip antenna: Microstrip antennas are called microstrip due to their small size. A microstrip antenna consists of radiating patch on one side of dielectric substrate which has a ground plane on the other side .The patch has different shapes: rectangular, circular, square, ring triangular…..etc.
Here the topic of discussion is triangular patch which has the reason for it .We can use shorting pin technique for each shape of the patch ,but if we use it for triangular patch the great reduction in the size of the antenna occurs, which is the main theme of this topic.

With the shorting pin loading technique , the antenna size reduction is mainly due to the shifting of the null –voltage point at the center of the rectangular patch and the circular patch to their respective patch edges ,which makes the shorted patches resonate at much lower frequency. Thus , at a given operating frequency , the required patch dimensions can be significantly reduced , and the reduction in the patch size is limited by the distance between the null –voltage point in the patch & patch edge. For this reason, compared to the case of shorting pin loaded rectangular & circular patches, it is expected that an equilateral triangular microstrip patch exited at its resonant mode where the null-voltage point is at two thirds of the distance from the triangle tip to the bottom edge of the triangle, will have a much larger reduction in the resonant frequency when applying the shorting pin loading technique.

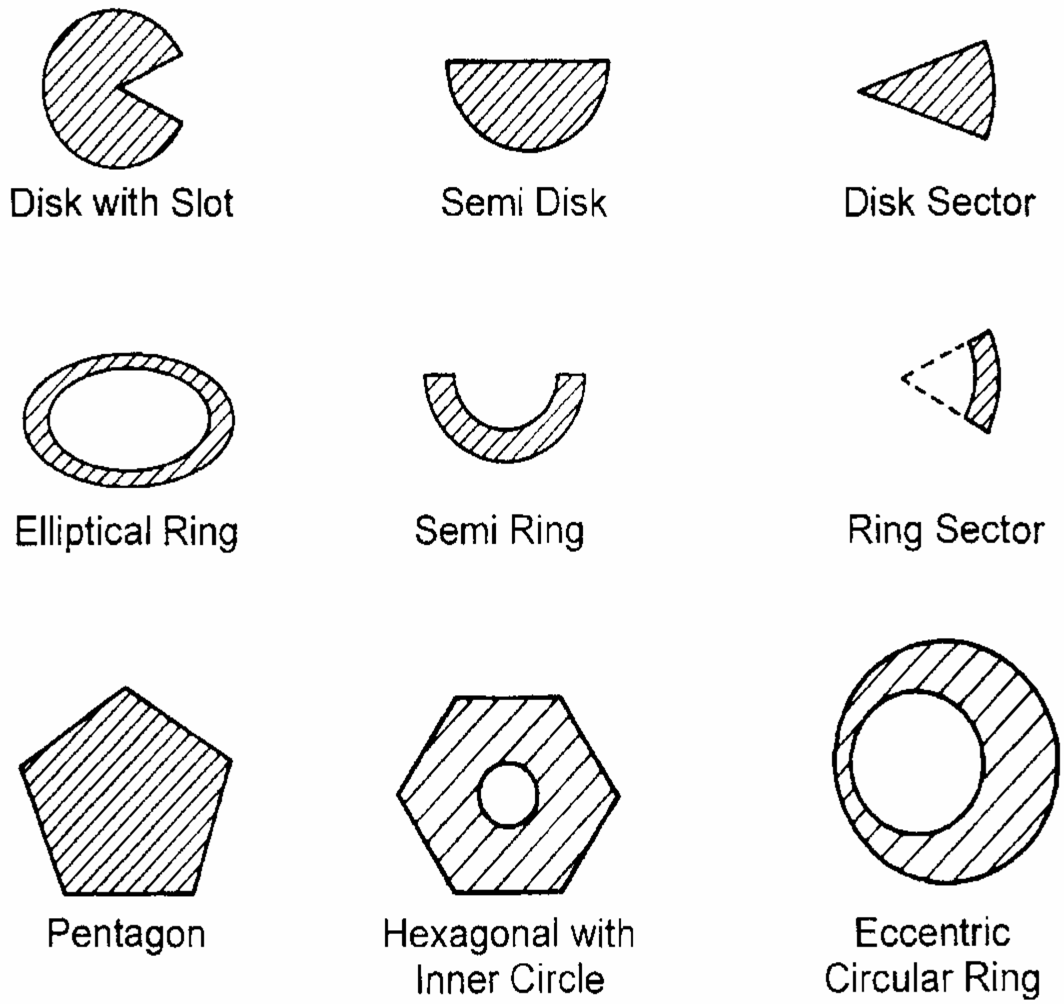
But with same relative permittivity, with & without shorting pin the size reduction is achieved when we use shorting pin & but using shorting pin the performance (efficiency ,B.W.) are decreased .So there is compromise between antenna size & performance.

SIMPLE SHAPES

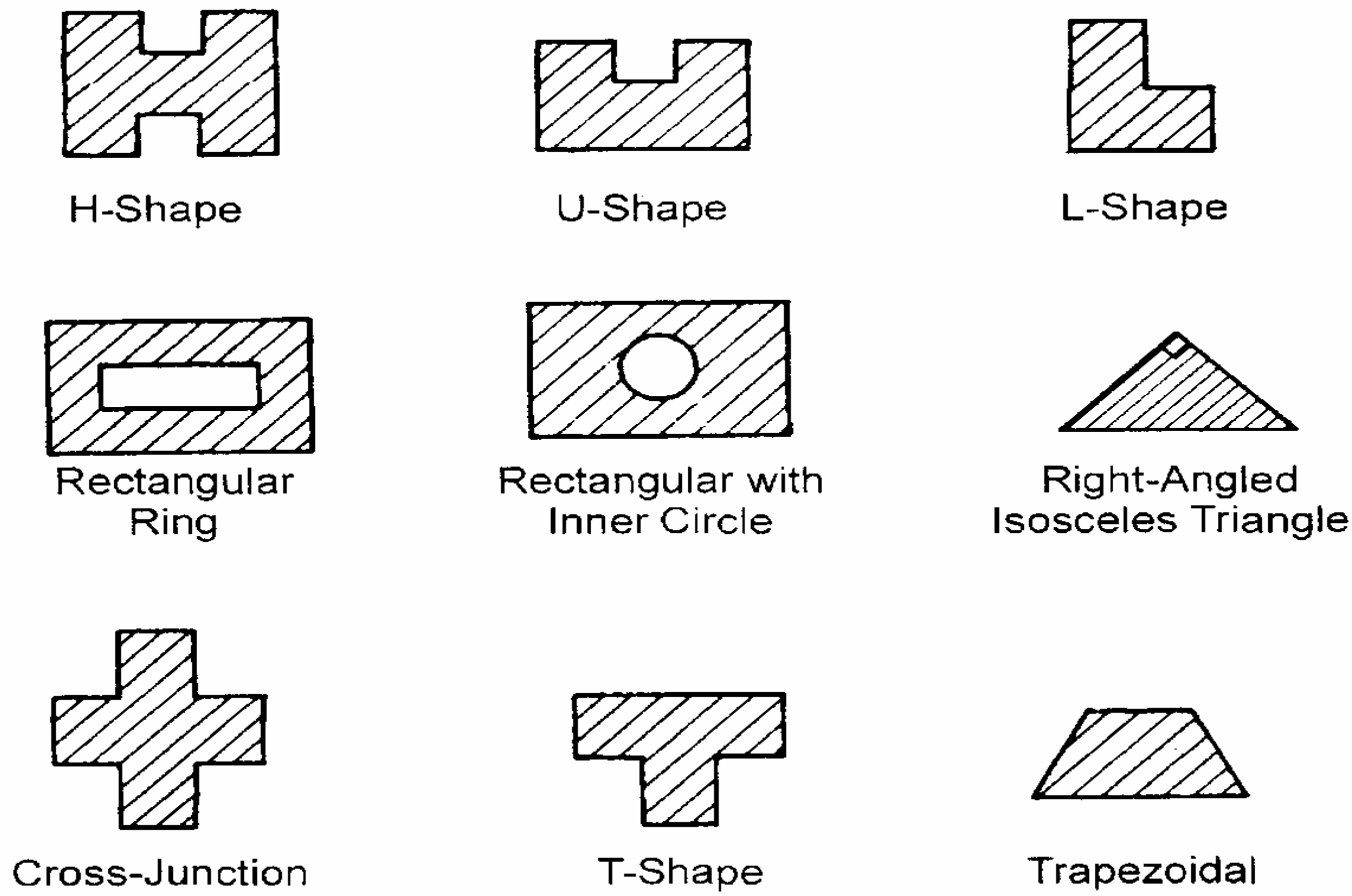


(a)

TYPICAL SHAPES

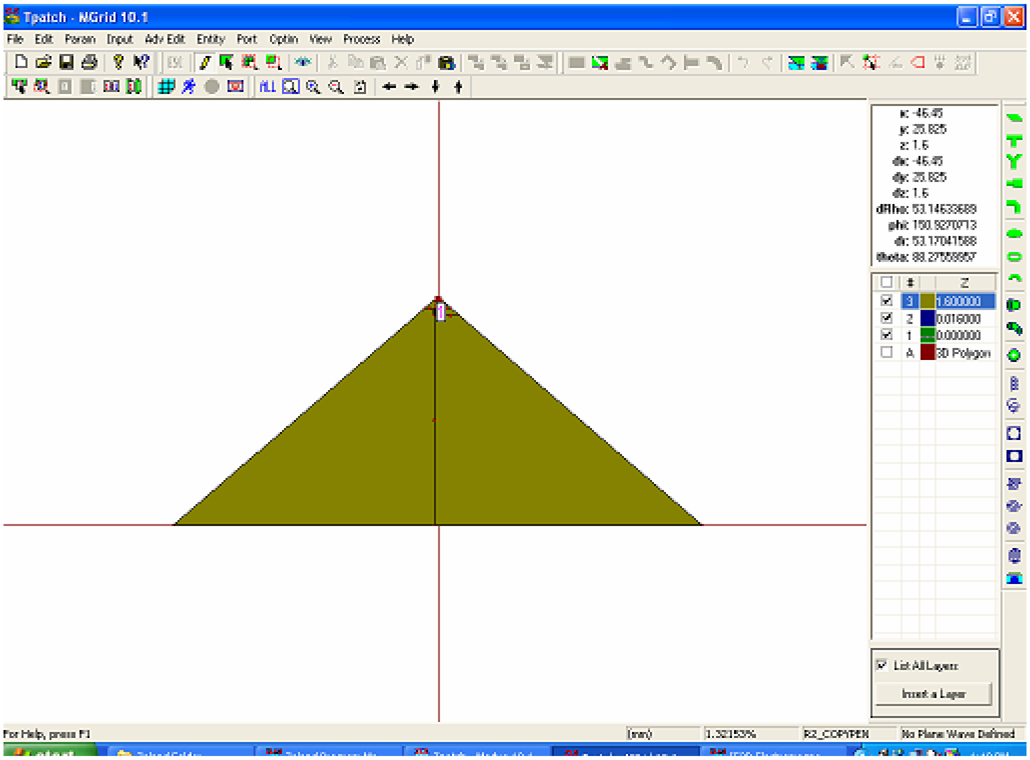

Disk with Slot
Semi Disk
Disk Sector
Elliptical Ring
Semi Ring
Ring Sector
Pentagon
Hexagonal with Inner Circle
Eccentric Circular Ring

COMPLICATED SHAPES


H-Shape
U-Shape
L-Shape
Rectangular Ring
Rectangular with Inner Circle
Right-Angled Isosceles Triangle
Cross-Junction
T-Shape
Trapezoidal

CHAPTER - 3

SIMULATION RESULTS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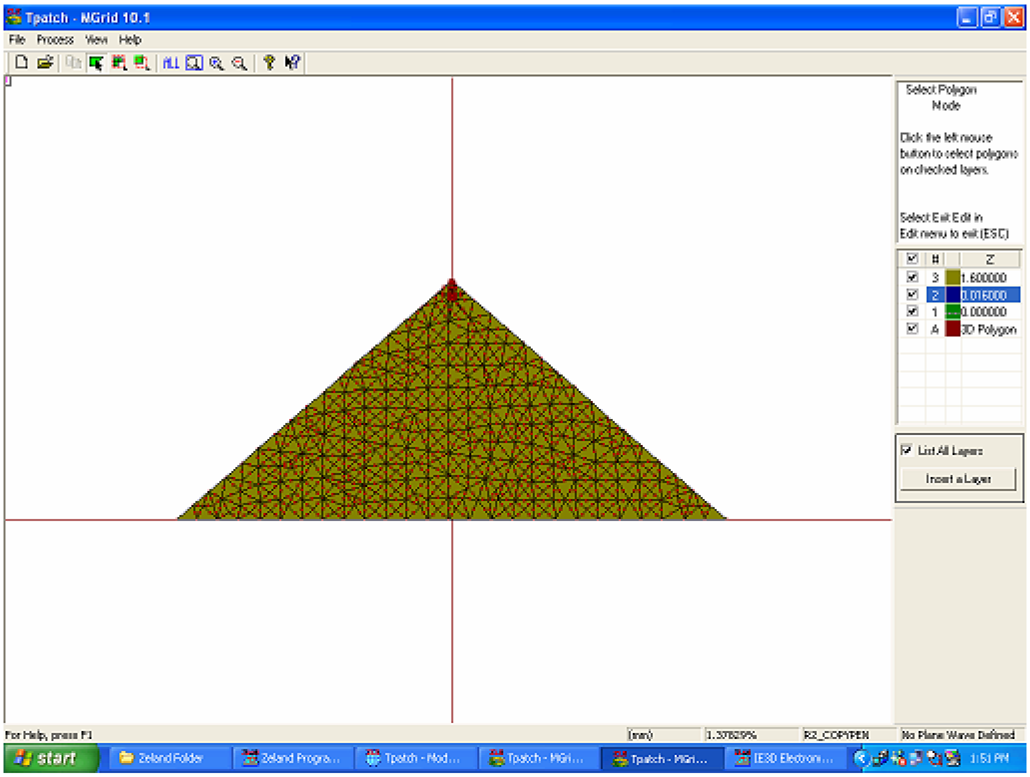
y: 25.825
z: 1.6
dx: -46.45
dy: 25.825
dz: 1.6
dRho: 53.14633689
phi: 150.9270713
dr: 53.17041588
theta: 88.27559957
#
Z
3
1.600000
2
0.016000
1
0.000000
A
3D Polygon
List All Layers
Insert a Layer
For Help, press F1
(mm)
1.32153%
R2_COPYPEN
No Plane Wave Defined


Tpatch - MGrid 10.1
File Process View Help
Select Polygon Mode
Click the left mouse button to select polygons on checked layers.
Select Exit Edit in Edit menu to exit (ESC)
3 1.600000
2 0.016000
1 0.000000
A 3D Polygon
List All Layers
Insert a Layer
For Help, press F1
R2_COPYPEN
No Plane Wave Defined
start
Zeland Folder
1:51 PM

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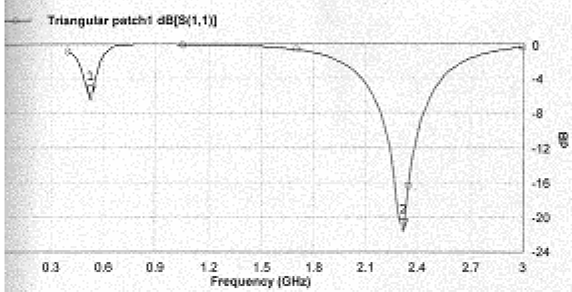


Information List

urrent Reference Mode: X Axis

elected Dot List

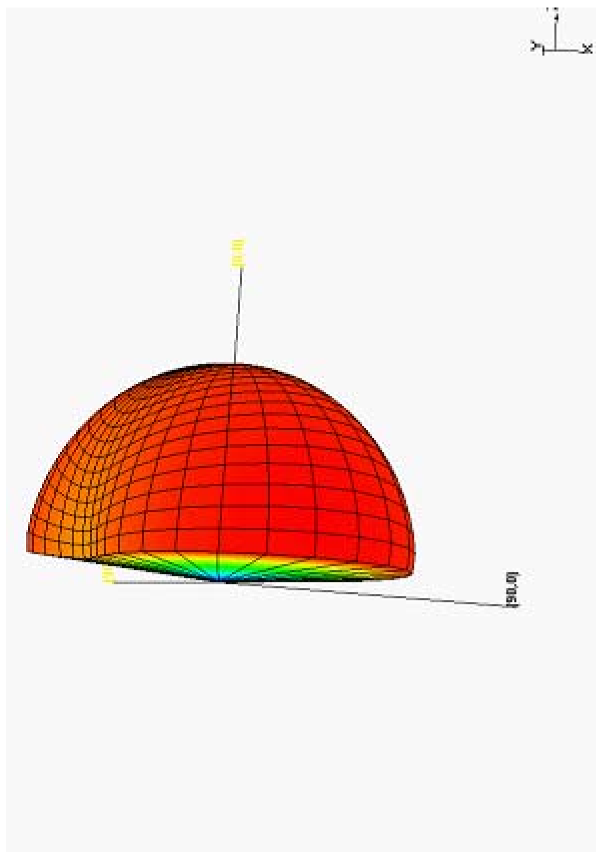
No.	X	Y
1	0.528	-6.30517
2	2.316	-21.7076

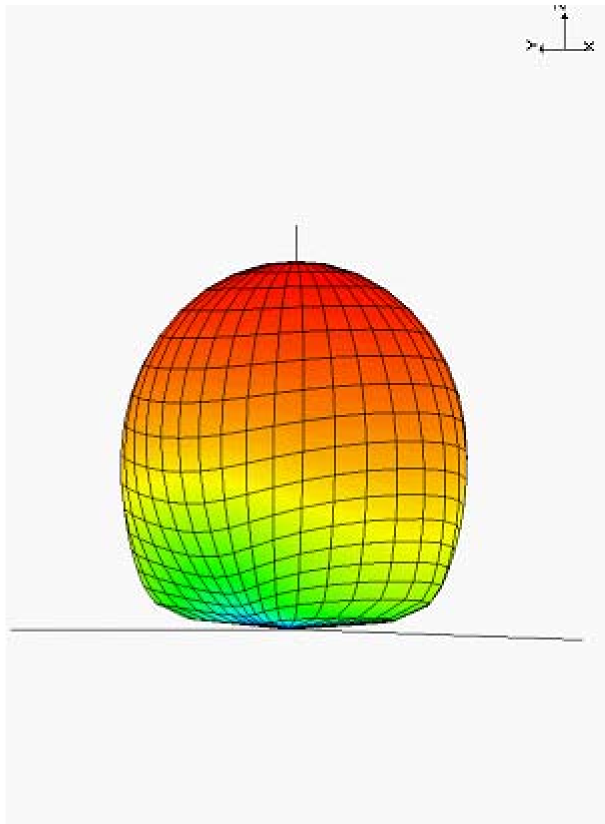
ifference Between Point 1 And Point 1

dX:	dY:
0	0

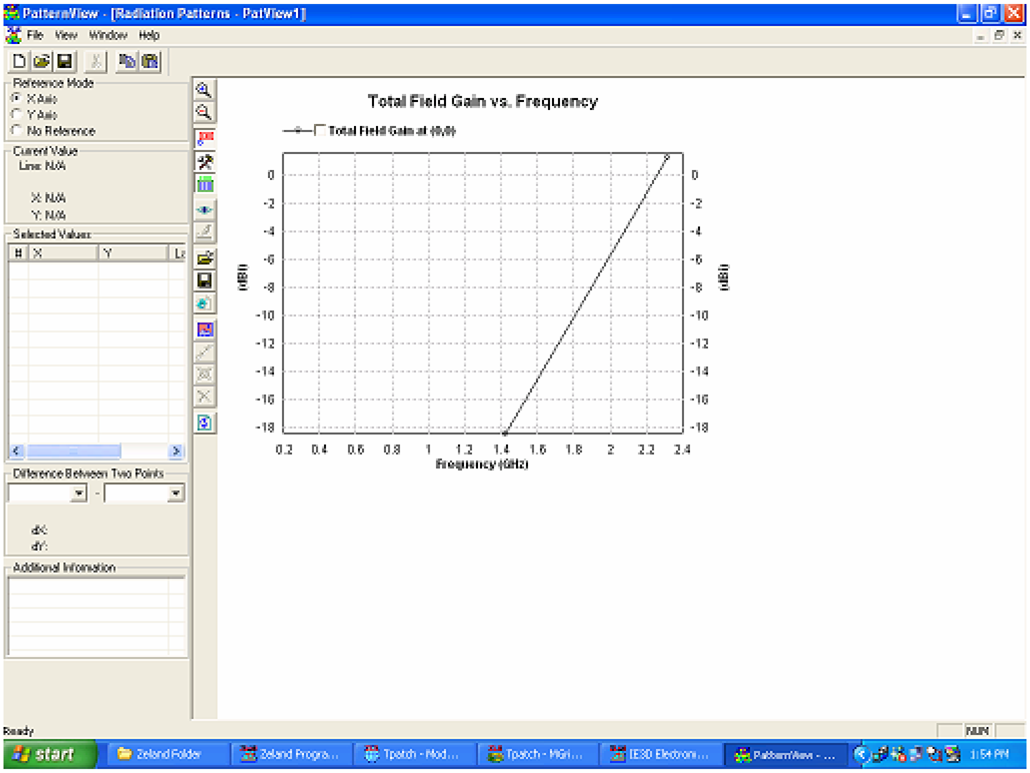
dditional Information List

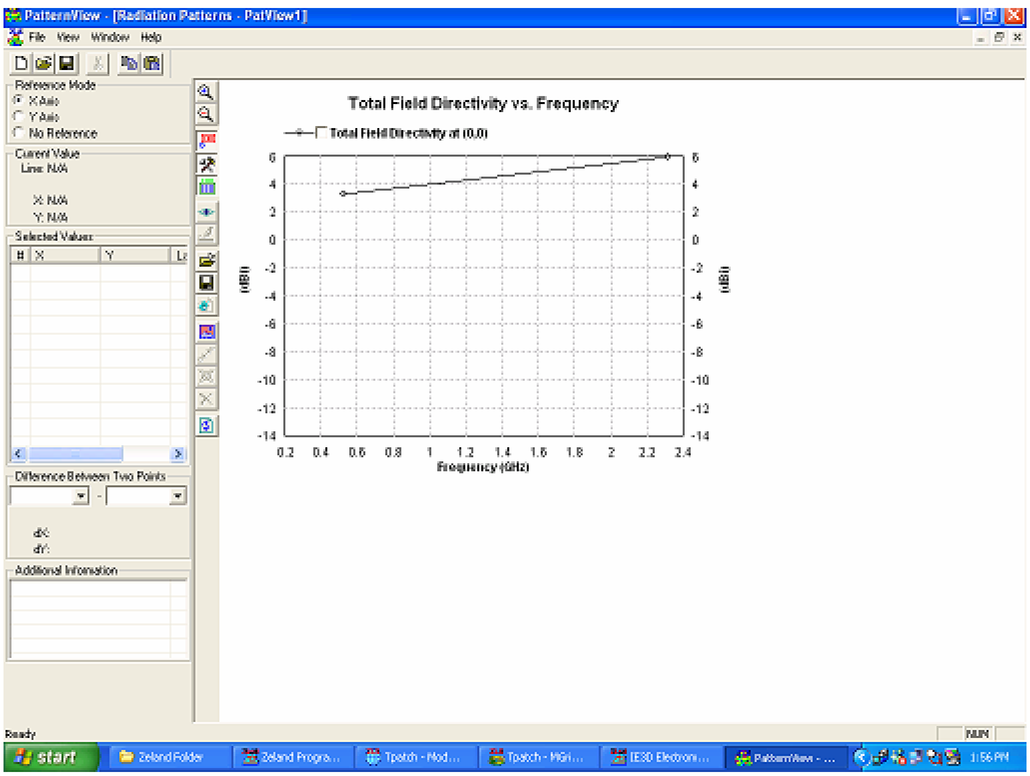
c(1) = 50 Ohms





Y
X

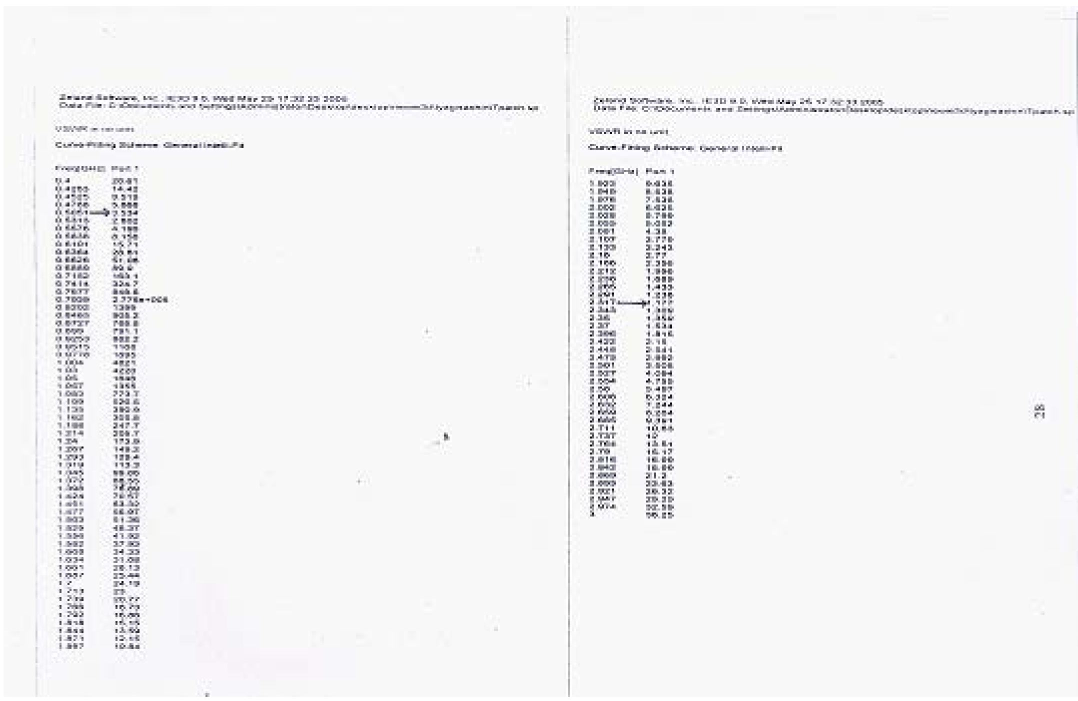

PatternView - [Radiation Patterns - PatView1]
Total Field Gain vs. Frequency
Total Field Gain at (0,0)
(dBi)
Frequency (GHz)
Reference Mode
Current Value
Selected Values
Difference Between Two Points
Additional Information

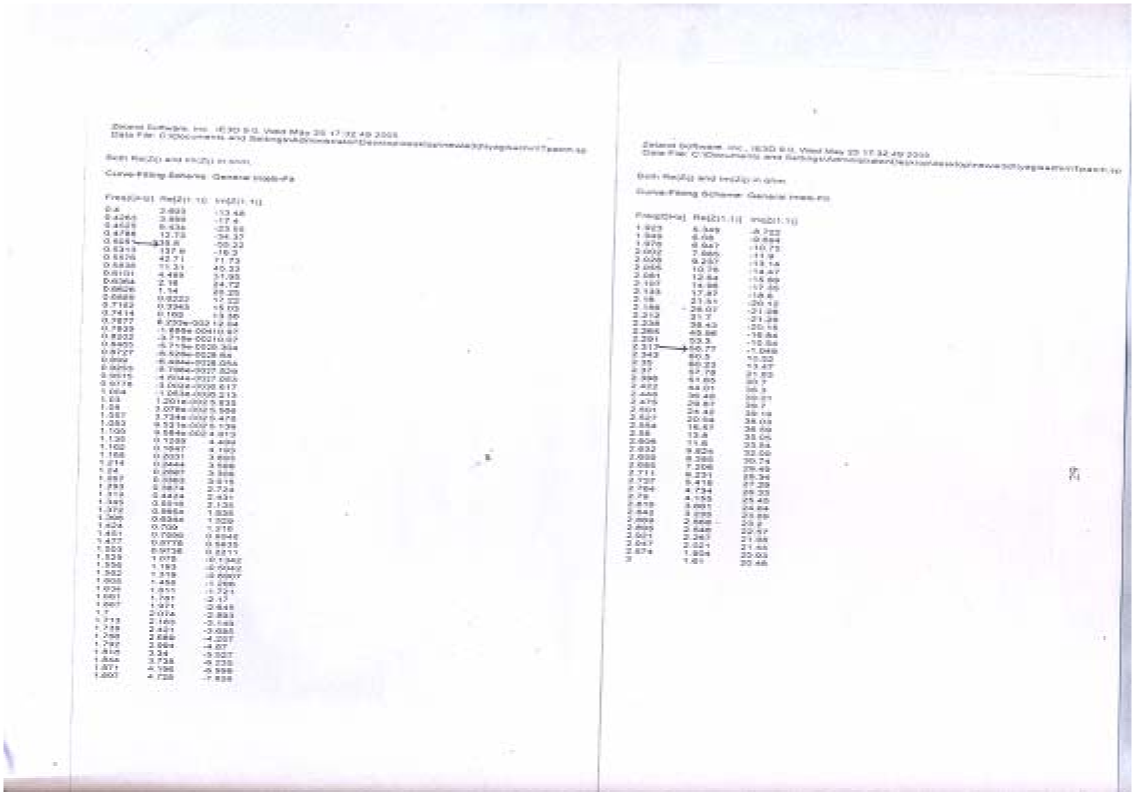

PatternView - [Radiation Patterns - PatView1]
File View Window Help
Reference Mode
X Axis
Y Axis
No Reference
Current Value
Line: N/A
X: N/A
Y: N/A
Selected Values
Difference Between Two Points
dX:
dY:
Additional Information
Total Field Directivity vs. Frequency
Total Field Directivity at (0,0)
(dBi)
Frequency (GHz)
Ready
start

File Name:	C:\Documents and Settings\Administrator\Desktop\desktop\newie3d\tyagisachin\Tpatch.pat
Pattern ID:	
Port Number:	1
Frequency:	0.528 (GHz)
Incident Power:	0.01 (W)
Input Power:	2.24023e-005 (W)
Radiated Power:	6.91315e-007 (W)
Average Radiated Power:	5.50131e-008 (W/s)
Radiation Efficiency:	3.08591%
Antenna Efficiency:	0.00691315%
Total Field Properties:	
Gain:	-37.2064 dBi
Directivity:	4.39689 dBi
Maximum:	at (80, 90) deg.
3dB Beam Width:	(84.1988, 174.878) deg.
Theta Field Properties:	
Gain:	-37.2064 dBi
Directivity:	4.39689 dBi
Maximum:	at (80, 90) deg.
3dB Beam Width:	(65.6267, 129.133) deg.
Phi Field Properties:	
Gain:	-38.382 dBi
Directivity:	3.22127 dBi
Maximum:	at (0, 0) deg.
3dB Beam Width:	(5, 89.4221) deg.
Left-Hand Circular Field:	

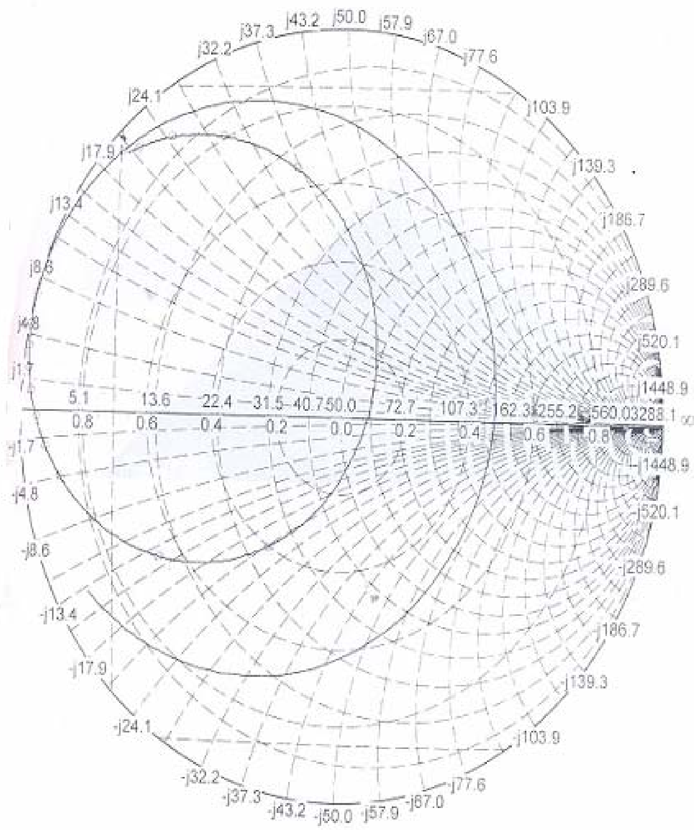
Properties	
Gain:	-39.1202 dBi
Directivity:	2.48306 dBi
Maximum:	at (40, 0) deg.
3dB Beam Width:	(0, 0) deg.
Right-Hand Circular Field Properties:	
Gain:	-39.1202 dBi
Directivity:	2.48303 dBi
Maximum:	at (40, 180) deg.
3dB Beam Width:	(79.8003, 171.492) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=0.0607796/87.2018 (V), I=0.0399591/-1.74118 (A)
:	Inc=1/-2.98177e-015 (V), Ref=0.998879/176.516 (V)
Frequency:	2.316 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.00521727 (W)
Radiated Power:	0.00340952 (W)
Average Radiated Power:	0.000271321 (W/s)
Radiation Efficiency:	65.3507%
Antenna Efficiency:	34.0952%
Total Field Properties:	
Gain:	1.18443 dBi
Directivity:	5.8575 dBi
Maximum:	at (0, 20) deg.
3dB Beam Width:	(102.061, 146.069) deg.
Theta Field Properties:	
Gain:	1.18443 dBi
Directivity:	5.8575 dBi
Maximum:	at (0, 90) deg.
3dB Beam Width:	(0, 0) deg.

Phi Field Properties:	
Gain:	1.18443 dBi
Directivity:	5.8575 dBi
Maximum:	at (0, 0) deg.
3dB Beam Width:	(5, 81.9547) deg.
Left-Hand Circular Field Properties:	
Gain:	-0.45732 dBi
Directivity:	4.21575 dBi
Maximum:	at (25, 180) deg.
3dB Beam Width:	(59.5631, 113.338) deg.
Right-Hand Circular Field Properties:	
Gain:	-0.462177 dBi
Directivity:	4.21089 dBi
Maximum:	at (25, 0) deg.
3dB Beam Width:	(0, 0) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=1.09436/38.2285 (V), I=0.0265249/-30.704 (A)
:	Inc=1/-7.95139e-014 (V), Ref=0.691573/101.707 (V)





Triangular patch¹ S(1,1)



Information List

rrent Reference Mode: Impedence

lected Dot List

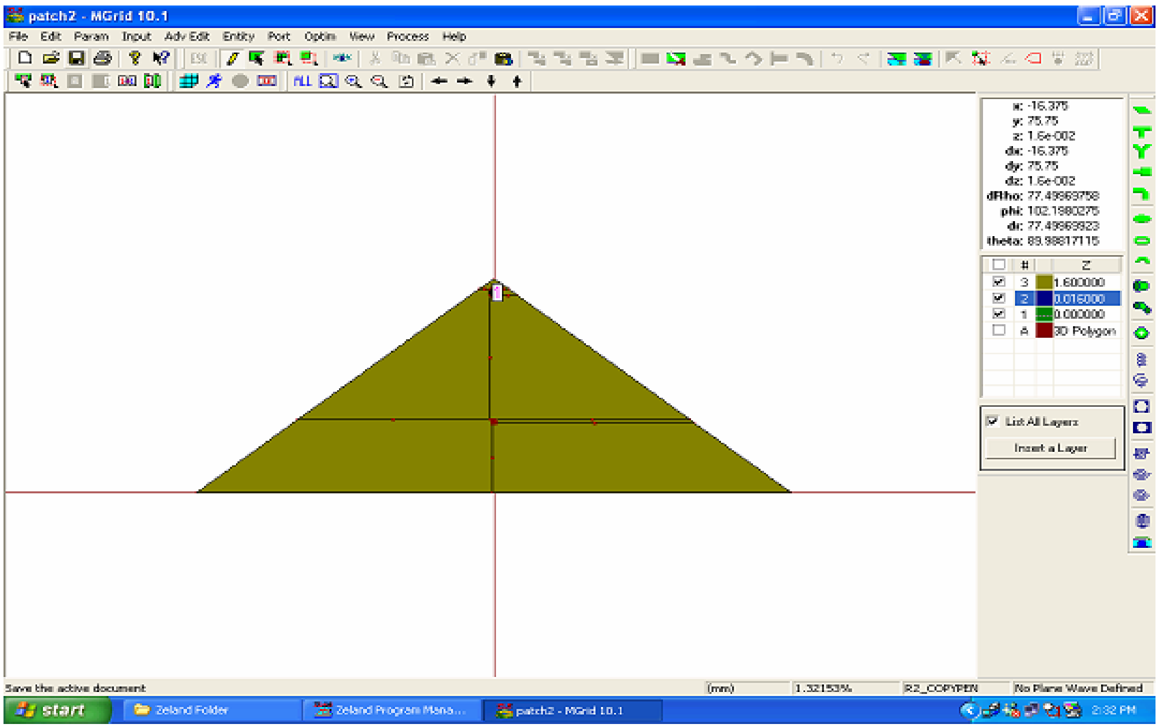
No.	Freq	Re(Zs)	Im(Zs)

fference Between Point And Point

dFreq:	dRe(Zs):	dIm(Zs):

ditional Information List

30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File Edit Param Input Adv Edit Entity Port Optim View Process Help
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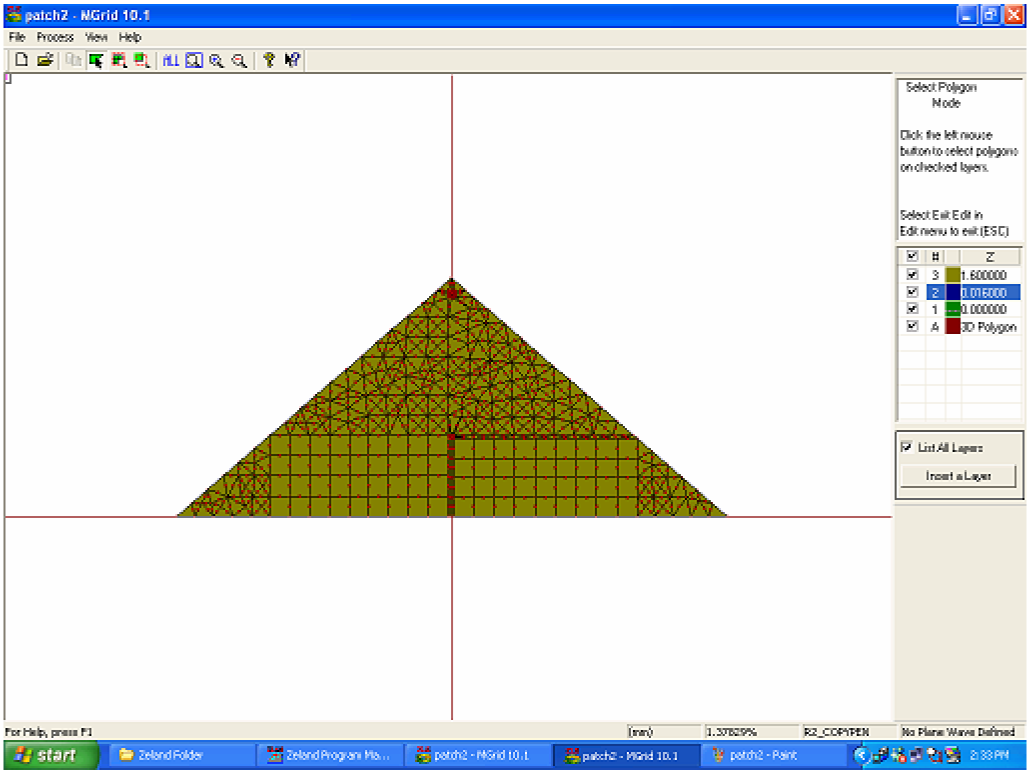
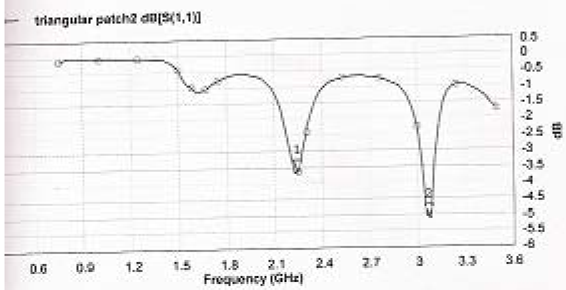
y: 75.75
z: 1.6e-002
dx: -16.375
dy: 75.75
dz: 1.6e-002
dRho: 77.49969758
phi: 102.1980275
dr: 77.49969923
theta: 89.98817115
Z
3 1.600000
2 0.016000
1 0.000000
A 3D Polygon
List All Layers
Insert a Layer
Save the active document
(mm)
1.32153%
R2_COPYPEN
No Plane Wave Defined
start
Zeland Folder
Zeland Program Mana...
patch2 - MGrid 10.1
2:32 PM


patch2 - MGrid 10.1
File Process View Help
Select Polygon Mode
Click the left mouse button to select polygons on checked layers.
Select Exit Edit in Edit menu to exit (ESC)
#
Z
3
1.600000
2
0.016000
1
0.000000
A
3D Polygon
List All Layers
Insert a Layer
For Help, press F1
(mm)
R2_COPYPEN
No Plane Wave Defined
start
Zeland Folder
patch2 - MGrid 10.1
patch2 - Paint

\Documents and Settings\Administrator\Desktop\Desktop...



Information List

urrent Reference Mode: X Axis

elected Dot List

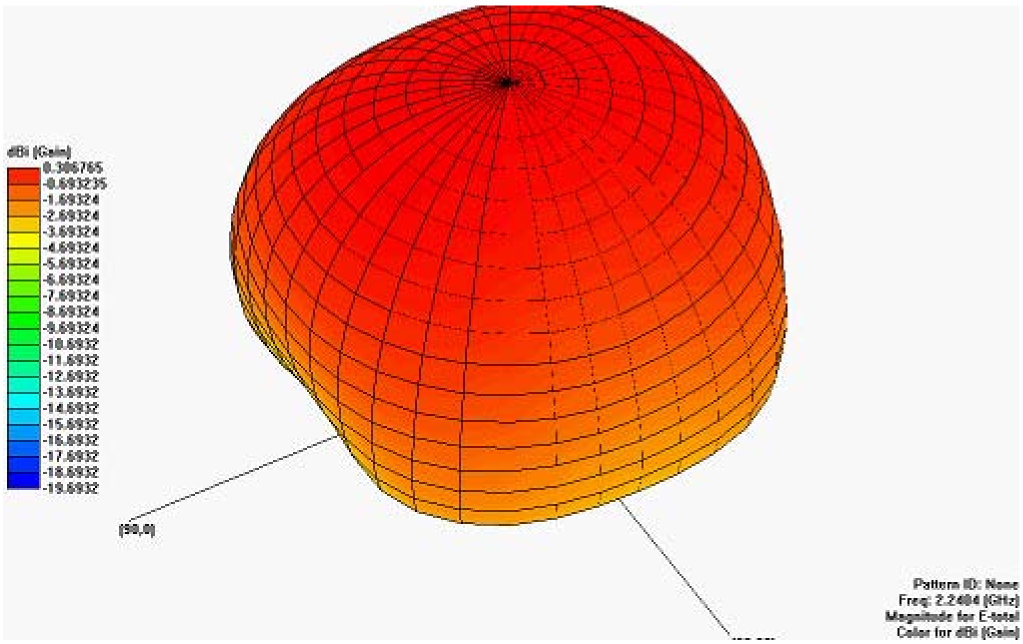
No.	X	Y
1	2.2404	-3.64748
2	3.0654	-5.08996

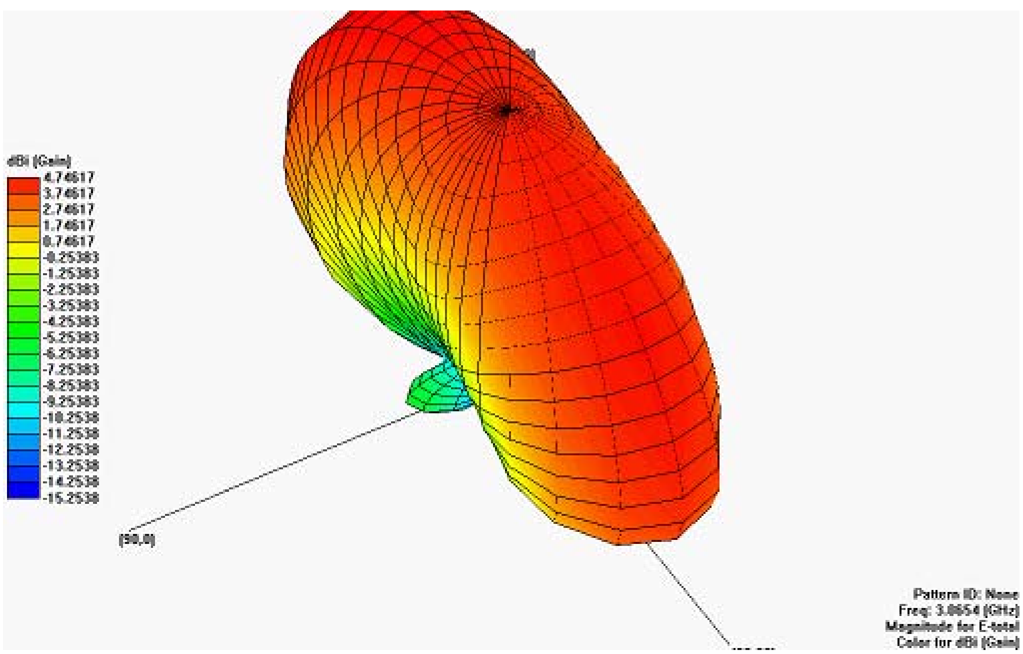
ifference Between Point 1 And Point 1

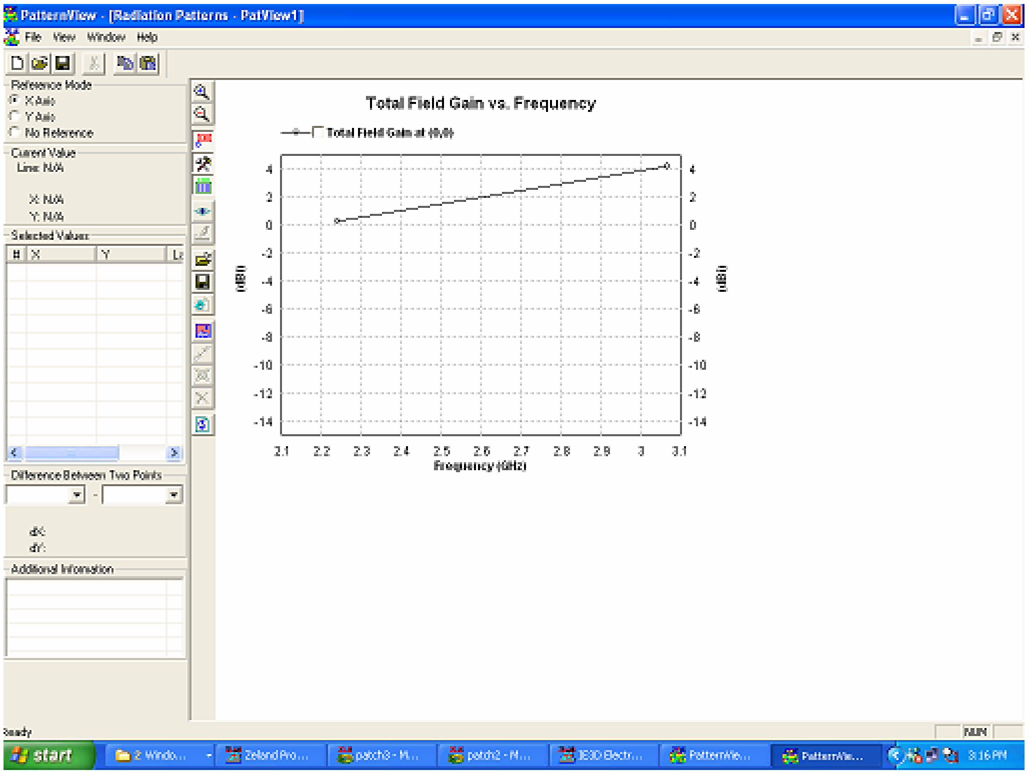
dX:	dY:
0	0

dditional Information List

Z(1) = 50 Ohms


dBi (Gain)
0.306765
-0.693235
-1.69324
-2.69324
-3.69324
-4.69324
-5.69324
-6.69324
-7.69324
-8.69324
-9.69324
-10.6932
-11.6932
-12.6932
-13.6932
-14.6932
-15.6932
-16.6932
-17.6932
-18.6932
-19.6932
(90,0)
Pattern ID: None
Freq: 2.2404 (GHz)
Magnitude for E-total
Color for dBi (Gain)


dBi (Gain)
4.74617
3.74617
2.74617
1.74617
0.74617
-0.25383
-1.25383
-2.25383
-3.25383
-4.25383
-5.25383
-6.25383
-7.25383
-8.25383
-9.25383
-10.2538
-11.2538
-12.2538
-13.2538
-14.2538
-15.2538
(90,0)
Pattern ID: None
Freq: 3.0654 (GHz)
Magnitude for E-total
Color for dBi (Gain)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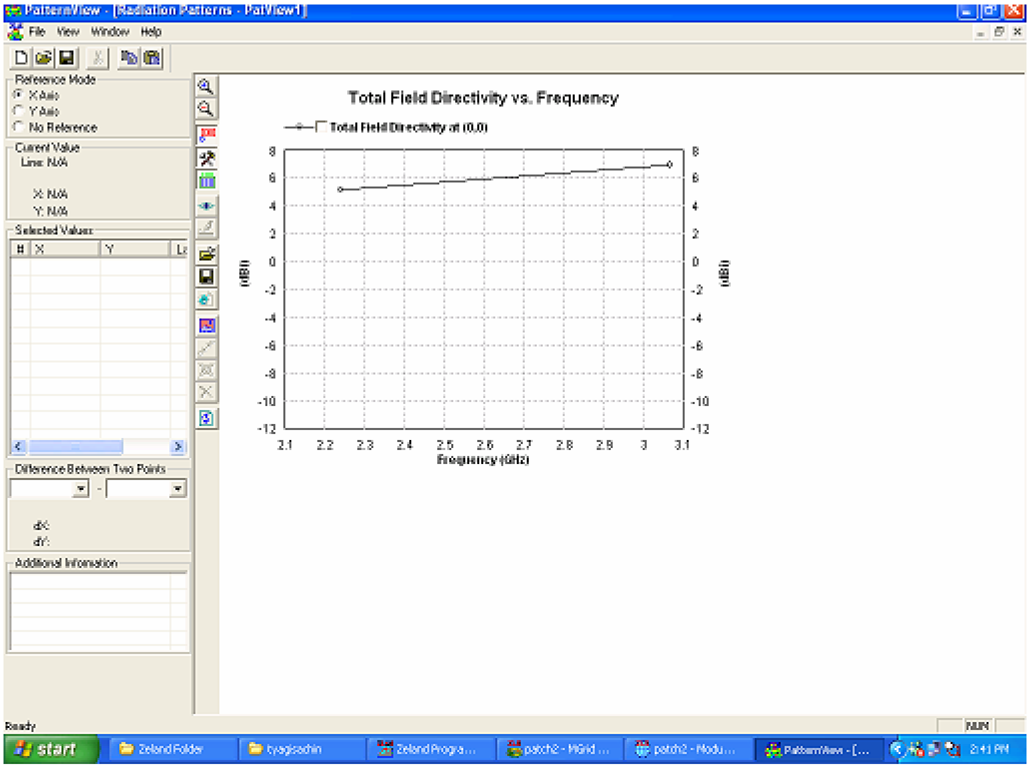
File View Window Help
Reference Mode
X Axis
Y Axis
No Reference
Current Value
Line: N/A
X: N/A
Y: N/A
Selected Values
Difference Between Two Points
dX:
dY:
Additional Information
Total Field Gain vs. Frequency
Total Field Gain at (0,0)
(dBi)
Frequency (GHz)
Ready
NUM
start
3:16 PM


PatternView - [Radiation Patterns - PatView1]
File View Window Help
Reference Mode
X Axis
Y Axis
No Reference
Current Value
Line: N/A
X: N/A
Y: N/A
Selected Values
Difference Between Two Points
dX:
dY:
Additional Information
Total Field Directivity vs. Frequency
Total Field Directivity at (0,0)
(dBi)
Frequency (GHz)
Ready
start

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Pattern ID:	
Port Number:	1
Frequency:	2.2404 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.00577547 (W)
Radiated Power:	0.00329438 (W)
Average Radiated Power:	0.000262158 (W/s)
Radiation Efficiency:	57.0409%
Antenna Efficiency:	32.9438%
Total Field Properties:	
Gain:	0.306765 dBi
Directivity:	5.12903 dBi
Maximum:	at (15, 180) deg.
3dB Beam Width:	(59.9559, 157.667) deg.
Theta Field Properties:	
Gain:	0.283431 dBi
Directivity:	5.10569 dBi
Maximum:	at (0, 270) deg.
3dB Beam Width:	(0, 0) deg.
Phi Field Properties:	
Gain:	0.283431 dBi
Directivity:	5.10569 dBi
Maximum:	at (0, 180) deg.
3dB Beam Width:	(5, 91.1313) deg.
Left-Hand Circular Field: Properties	
Gain:	-0.331226 dBi
Directivity:	4.49104 dBi
Maximum:	at (30, 180) deg.
3dB Beam Width:	(62.6307, 103.163) deg.
Right-Hand Circular Field: Properties	
Gain:	-0.332099 dBi
Directivity:	4.49016 dBi
Maximum:	at (30, 0) deg.
3dB Beam	

Width:	(0, 0) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=1.58717/-12.7015 (V), I=0.0114155/37.691 (A)
:	Inc=1/7.95139e-015 (V), Ref=0.649964/-32.4737 (V)

Frequency:	3.0654 (GHz)
icident Power:	0.01 (W)
Input Power:	0.00687727 (W)
diated Power:	0.00535177 (W)
Average diated Power:	0.00042588 (W/s)
Radiation Efficiency:	77.8183%
Antenna Efficiency:	53.5177%
Total Field Properties:	
Gain:	4.74617 dBi
Directivity:	7.4612 dBi
Maximum:	at (45, 270) deg.
3dB Beam Width:	(49.2068, 167.52) deg.
Theta Field Properties:	
Gain:	4.74617 dBi
Directivity:	7.46119 dBi
Maximum:	at (45, 270) deg.
3dB Beam Width:	(40.7637, 82.3107) deg.
Phi Field Properties:	
Gain:	4.16672 dBi
Directivity:	6.88175 dBi
Maximum:	at (0, 180) deg.
3dB Beam Width:	(5.00002, 46.9203) deg.
Left-Hand Circular Field: Properties	
Gain:	1.91256 dBi
Directivity:	4.62759 dBi
Maximum:	at (40, 280) deg.
3dB Beam Width:	(46.6011, 167.876) deg.
Right-Hand Circular Field: Properties	
Gain:	1.90279 dBi
Directivity:	4.61781 dBi
Maximum:	at (40, 260) deg.
3dB Beam	

Width:	(46.5223, 167.922) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=1.40334/-18.7905 (V), I=0.0161886/33.9488 (A)
:	Inc=1/0 (V), Ref=0.558814/-53.9892 (V)

Zeland Software, Inc., IE3D 9.0, Thu May 26 14:28:04 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\newie3d\nyagisachin\patch2.sp

VSWR in no unit.

Curve-Fitting Scheme: General Intelli-Fit

Freq[GHz]	Port 1
0.75	135.3
0.7778	693.3
0.8056	191.8
0.8333	166
0.8611	191.7
0.8889	275.7
0.9167	567.3
0.9444	1.114e+004
0.9722	684.3
1	312.1
1.028	229.9
1.056	192.3
1.083	173.6
1.111	166.5
1.139	164.8
1.167	170.9
1.194	184.5
1.222	206.2
1.25	247.3
1.278	312.7
1.306	423.4
1.333	593.1
1.361	701.7
1.389	503.1
1.417	251.2
1.444	122.5
1.472	66.59
1.5	40.95
1.528	29.25
1.556	21.39
1.583	17.58
1.611	15.83
1.639	15.62
1.667	16.53
1.694	18.16
1.722	20.26
1.75	22.58
1.778	24.97
1.806	27.28
1.833	29.34
1.861	30.98
1.889	32.04
1.917	32.34
1.944	31.79
1.972	30.36
2	28.09
2.028	25.12
2.056	21.66
2.083	17.92
2.111	14.2
2.139	10.76
2.167	7.888
2.194	5.841
2.222	4.903
2.24	4.714
2.25	4.852
2.278	5.595
2.3	7.29
2.306	7.698
2.333	9.981

Zeland Software, Inc., IE3D 9.0, Thu May 26 14:26:04 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\new\e3d\yagswithmpatch2.sp

VSWR in no unit

Curve-Fitting Schema: General Intelli-Fit

Freq[GHz]	Part 1
2.361	12.48
2.389	14.97
2.417	17.3
2.444	19.37
2.472	21.11
2.5	22.53
2.528	23.63
2.533	23.81
2.556	24.41
2.583	24.91
2.611	25.16
2.639	25.17
2.667	24.97
2.694	24.57
2.722	23.98
2.75	23.23
2.767	22.69
2.778	22.3
2.806	21.2
2.833	19.93
2.861	18.48
2.889	16.78
2.917	14.86
2.944	12.68
2.972	10.24
3.	7.645
3.028	5.209
3.056	3.659
3.065 →	3.533
3.083	4.114
3.111	6.947
3.139	10.85
3.167	14.47
3.194	16.67
3.222	17.63
3.25	17.73
3.278	17.28
3.306	16.5
3.333	15.54
3.361	14.48
3.389	13.43
3.417	12.41
3.444	11.49
3.472	10.7
3.5	10.1

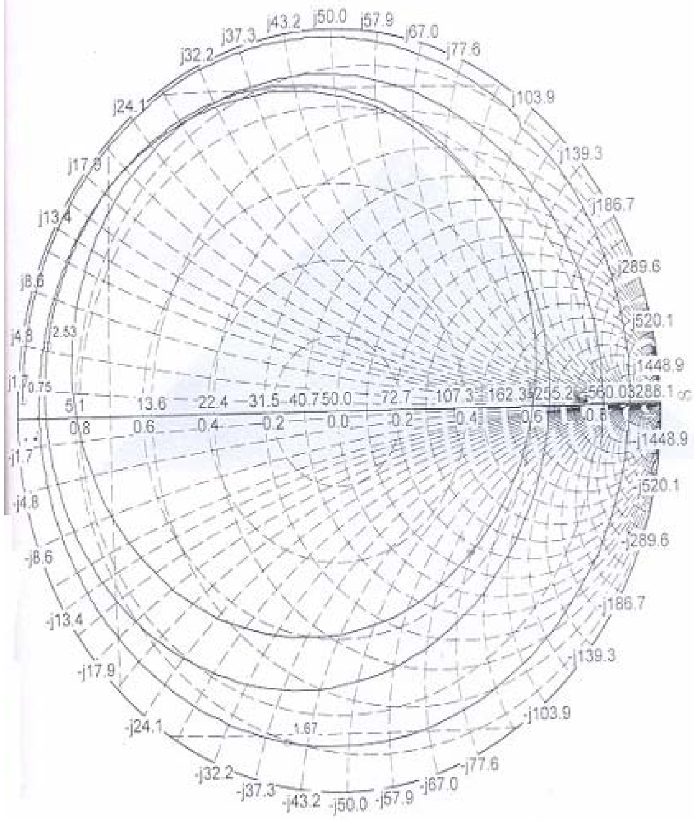
Zeland Software, Inc., IE3D 9.0, Thu May 26 14:38:08 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\newie3d\yagisachin\patch2.sp

Both Re(Zij) and Im(Zij) in ohm.

Freq[GHz]	Re[Z(1,1)]	Im[Z(1,1)]
0.75	0.3618	1.197
1	0.1708	12.84
1.25	0.2542	25.38
1.5	6.26	101.4
1.583	94.94	-260.8
1.667	5.895	-40.35
1.75	2.367	-13.1
2.24	88.64	-107.1
2.25	52.61	-89.65
2.3	10.5	-35.82
2.533	2.124	5.266
2.767	2.616	21.6
3	24.45	80.11
3.085	52.48	-88.89
3.25	4.135	34.06
3.5	302.1	-248.4

cuments and Settings\Administrator\Desktop Page: 1, 05/26/05 15:1

S(1,1)



Information List

ent Reference Mode: Impedence

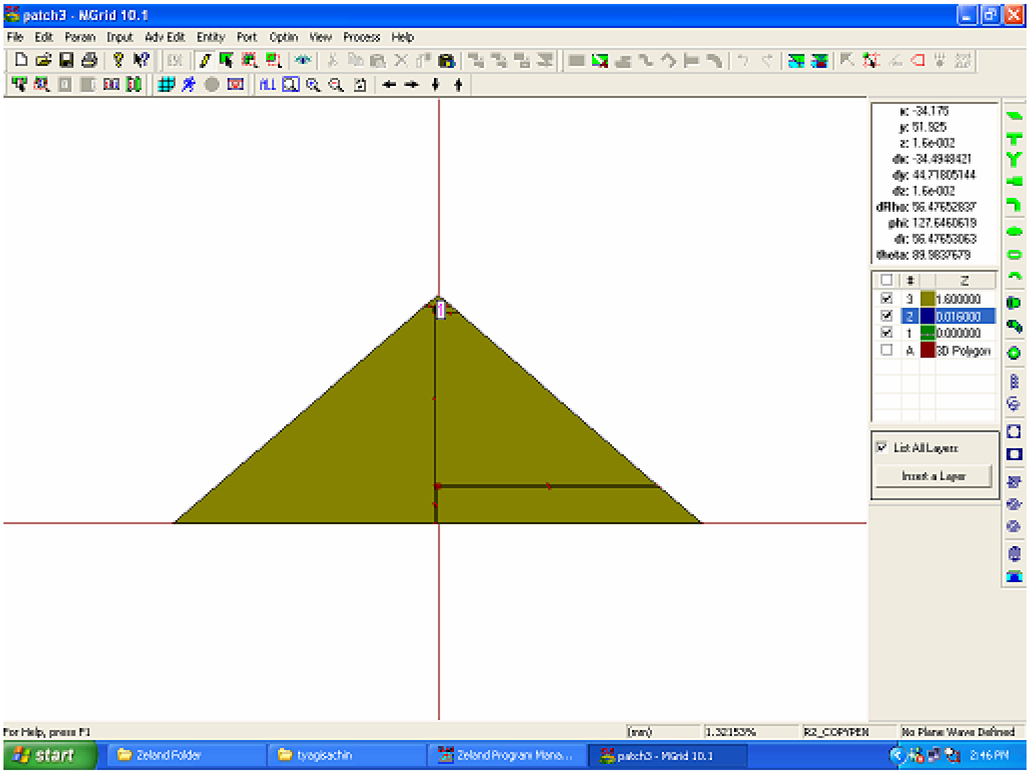
cted Dot List

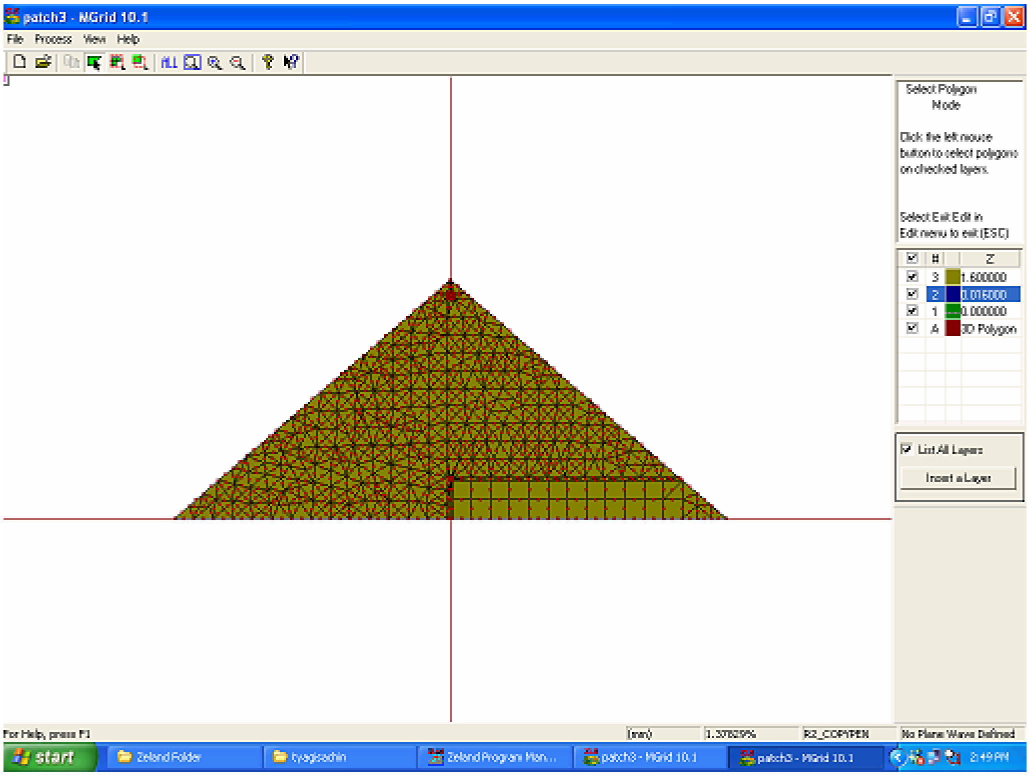
No.	Freq	Re(Zs)	Im(Zs)

ference Be[illegible]n Point And Point

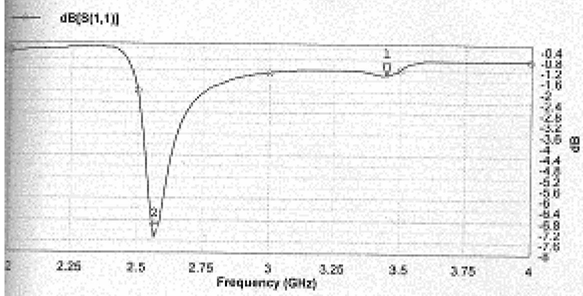
dFreq:	dRe(Zs):	dIm(Zs):

tional Information List


patch3 - MGrid 10.1
File Edit Param Input Adv Edit Entity Port Optim View Process Help
For Help, press F1
start
Zeland Folder
patch3 - MGrid 10.1
List All Layers
Insert a Layer
No Plane Wave Defined


patch3 - NGrid 10.1
File Process View Help
Select Polygon Mode
Click the left mouse button to select polygons on checked layers.
Select Exit Edit in Edit menu to exit (ESC)
List All Layers
Insert a Layer
For Help, press F1
No Plane Wave Defined
start

Page: 1, 05/27/05 11:29:48



Information List

Current Reference Node: X Axis

Selected Dot List

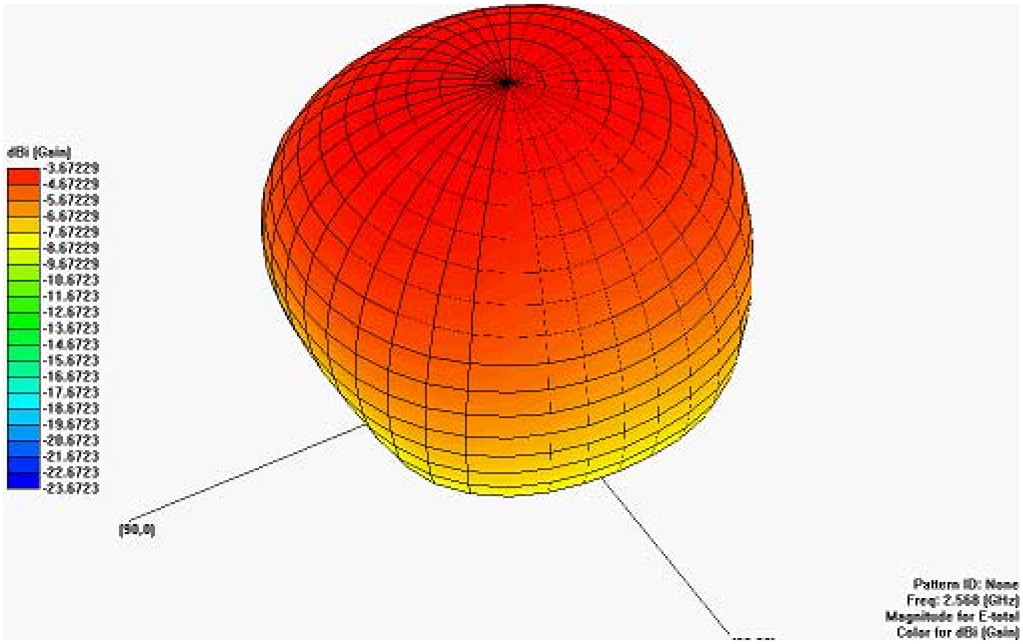
No.	X	Y
1	3.448	-1.37629
2	2.568	-7.40268

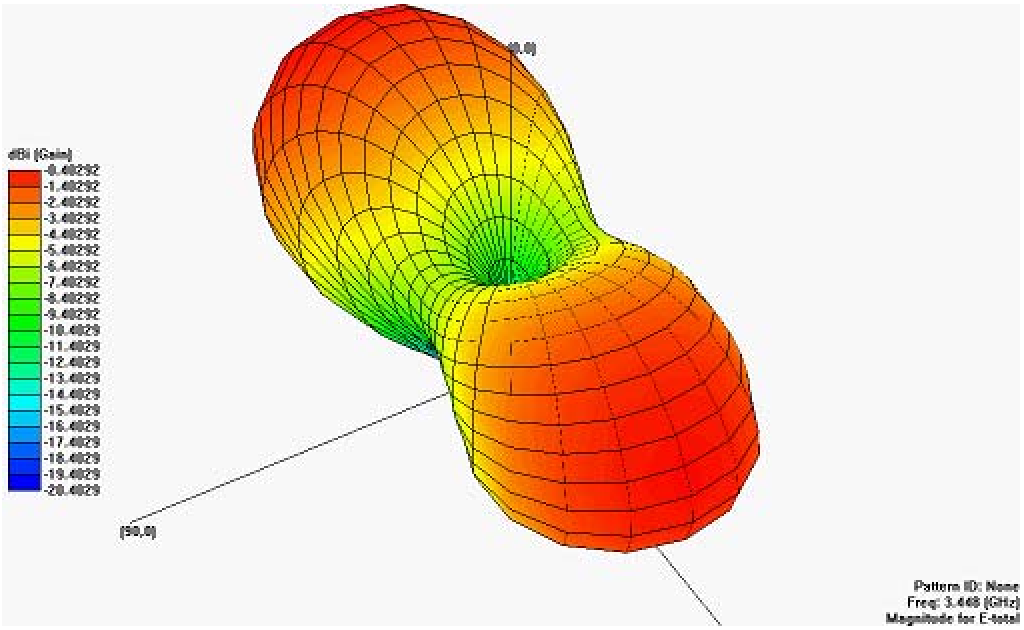
Difference Between Point 1 And Point 1

dX:	dY:
0	0

Additional Information List

Zc(1) = 50 Ohms


dBi (Gain)
-3.67229
-4.67229
-5.67229
-6.67229
-7.67229
-8.67229
-9.67229
-10.6723
-11.6723
-12.6723
-13.6723
-14.6723
-15.6723
-16.6723
-17.6723
-18.6723
-19.6723
-20.6723
-21.6723
-22.6723
-23.6723
(90,0)
Pattern ID: None
Freq: 2.568 (GHz)
Magnitude for E-total
Color for dBi (Gain)


dBi (Gain)
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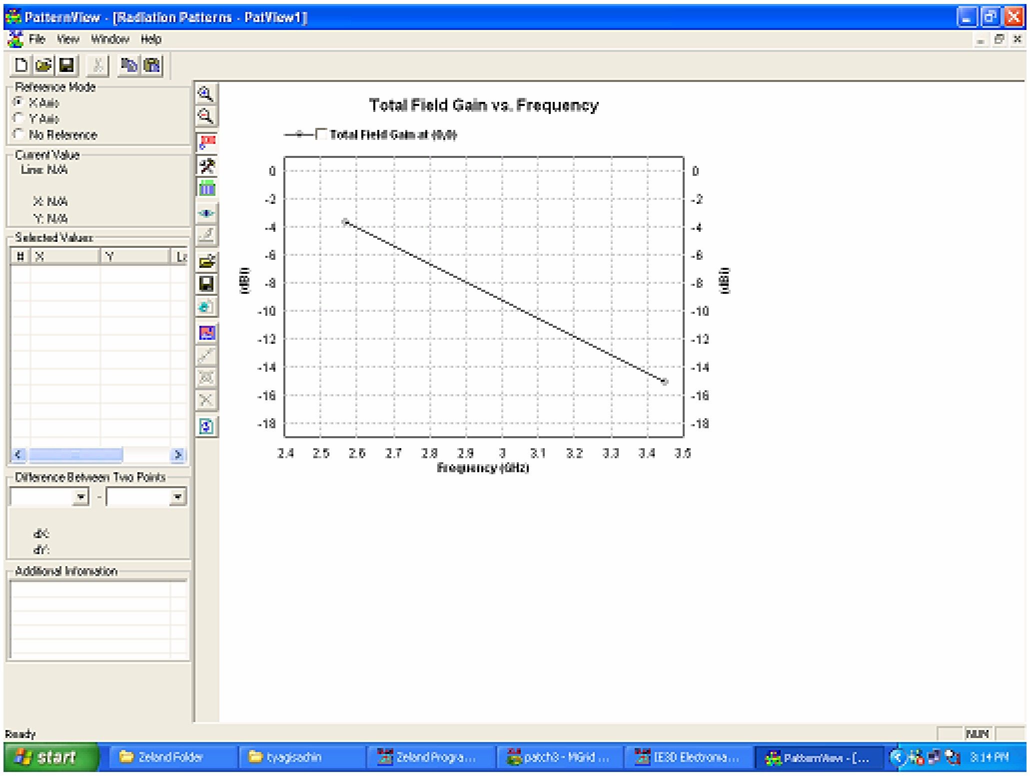
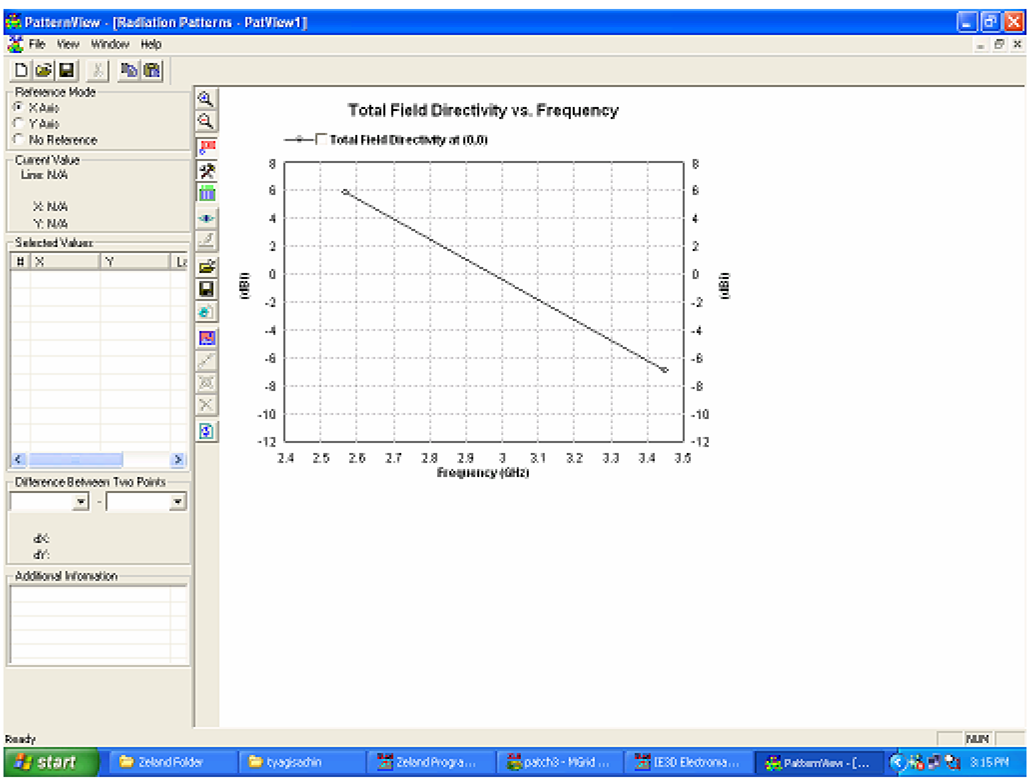
-1.40292
-2.40292
-3.40292
-4.40292
-5.40292
-6.40292
-7.40292
-8.40292
-9.40292
-10.4029
-11.4029
-12.4029
-13.4029
-14.4029
-15.4029
-16.4029
-17.4029
-18.4029
-19.4029
-20.4029
(0,0)
(90,0)
Pattern ID: None
Freq: 3.448 (GHz)
Magnitude for E-total


PatternView - [Radiation Patterns - PatView1]
Total Field Gain vs. Frequency
Total Field Gain at (0,0)
(dBi)
Frequency (GHz)


PatternView - [Radiation Patterns - PatView1]
File View Window Help
Reference Mode
X Axis
Y Axis
No Reference
Current Value
Line: N/A
X: N/A
Y: N/A
Selected Values
Difference Between Two Points
Additional Information
Total Field Directivity vs. Frequency
Total Field Directivity at (0,0)
(dBi)
Frequency (GHz)
Ready
start

File Name:	C:\Documents and Settings\Administrator\Desktop\desktop\newie3d\tyagisachin\patch3.pat
Pattern ID:	
Port Number:	1
Frequency:	2.568 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.00262877 (W)
Radiated Power:	0.0011208 (W)
Average Radiated Power:	8.91905e-005 (W/s)
Radiation Efficiency:	42.6359%
Antenna Efficiency:	11.208%
Total Field Properties:	
Gain:	-3.67229 dBi
Directivity:	5.83243 dBi
Maximum:	at (5, 310) deg.
3dB Beam Width:	(62.5351, 125.392) deg.
Theta Field Properties:	
Gain:	-3.67372 dBi
Directivity:	5.83099 dBi
Maximum:	at (5, 270) deg.
3dB Beam Width:	(10.1948, 63.4094) deg.
Phi Field Properties:	
Gain:	-3.68703 dBi
Directivity:	5.81768 dBi
Maximum:	at (0, 180) deg.
3dB Beam Width:	(5.00001, 84.3954) deg.
Left-Hand Circular Field Properties:	
Gain:	-4.55086 dBi

Directivity:	4.95385 dBi
Maximum:	at (25, 180) deg.
3dB Beam Width:	(57.6587, 95.3701) deg.
Right-Hand Circular Field Properties:	
Gain:	-4.55106 dBi
Directivity:	4.95366 dBi
Maximum:	at (25, 0) deg.
3dB Beam Width:	(0, 0) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=0.23648/-47.6194 (V), I=0.0369774/5.42148 (A)
:	Inc=1/7.95139e-016 (V), Ref=0.858559/-168.261 (V)
Frequency:	3.448 (GHz)
Incident Power:	0.01 (W)
Input Power:	0.0025439 (W)
Radiated Power:	0.00150917 (W)
Average Radiated Power:	0.000120096 (W/s)
Radiation Efficiency:	59.3252%
Antenna Efficiency:	15.0917%
Total Field Properties:	
Gain:	-0.40292 dBi
Directivity:	7.80969 dBi
Maximum:	at (65, 270) deg.
3dB Beam Width:	(56.4448, 63.3094) deg.
Theta Field Properties:	
Gain:	-0.402926 dBi
Directivity:	7.80969 dBi
Maximum:	at (65, 270) deg.
3dB Beam Width:	(50.9063, 56.4443) deg.
Phi Field Properties:	

Gain:	-5.06749 dBi
Directivity:	3.14513 dBi
Maximum:	at (35, 230) deg.
3dB Beam Width:	(27.1691, 43.7394) deg.
Left-Hand Circular Field Properties:	
Gain:	-2.64202 dBi
Directivity:	5.57059 dBi
Maximum:	at (55, 250) deg.
3dB Beam Width:	(47.1967, 65.5223) deg.
Right-Hand Circular Field Properties:	
Gain:	-2.65347 dBi
Directivity:	5.55914 dBi
Maximum:	at (55, 290) deg.
3dB Beam Width:	(47.1757, 65.4638) deg.
No. 1 Port:	Inc=1/0 (V), Zs=(50,0) Ohms, Zc=(50,0) Ohm
:	V=1.76379/-17.4445 (V), I=0.0123334/59.0296 (A)
:	Inc=1/-5.40694e-014 (V), Ref=0.863487/-37.7592 (V)

Zeland Software, Inc., IE3D 9.0, Fri May 27 11:30:56 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\new ie3d\tyagisachin\patch3.sp

VSWR in no unit.

Curve-Fitting Scheme: General Intelli-Fit

Freq[GHz]	Port 1
2	34.58
2.02	35.1
2.04	35.66
2.061	36.27
2.081	36.93
2.101	37.66
2.121	38.48
2.141	39.34
2.162	40.31
2.182	41.37
2.202	42.53
2.222	43.8
2.242	45.17
2.263	46.62
2.283	48.11
2.303	49.53
2.323	50.7
2.343	51.32
2.364	50.87
2.384	48.71
2.404	44.22
2.424	37.27
2.444	28.69
2.465	20.07
2.485	12.85
2.5	8.863
2.505	7.79
2.525	4.889
2.545	3.042
2.566	2.47
2.586	2.623
2.606	3.173
2.626	3.903
2.646	4.7
2.667	5.507
2.687	6.294
2.707	7.043
2.727	7.748
2.747	8.408
2.768	9.017
2.788	9.582
2.808	10.1
2.828	10.58
2.848	11.03
2.869	11.44
2.889	11.82
2.909	12.17
2.929	12.49
2.949	12.79
2.97	13.06
2.99	13.31
3	13.43
3.01	13.54
3.03	13.75
3.051	13.94
3.071	14.11
3.091	14.26
3.111	14.39
3.131	14.5
3.152	14.6

Zeland Software, Inc., IE3D 9.0, Fri May 27 11:30:58 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\newie3d\dyagisachin\patch3.sp

VSWR in no unit.

Curve-Fitting Scheme: General Intelli-Fit

Freq[GHz]	Port 1
3.172	14.67
3.192	14.72
3.212	14.75
3.232	14.76
3.253	14.73
3.273	14.68
3.293	14.58
3.313	14.45
3.333	14.26
3.354	14.02
3.374	13.73
3.394	13.37
3.414	13
3.434	12.69
3.455	12.63
3.475	13.09
3.495	14.28
3.5	14.69
3.515	16.09
3.535	17.63
3.556	19.19
3.576	20.06
3.596	20.56
3.616	20.83
3.636	20.96
3.657	21.01
3.677	21.02
3.697	21.02
3.717	21
3.737	20.98
3.758	20.97
3.778	20.95
3.798	20.93
3.818	20.92
3.838	20.91
3.859	20.91
3.879	20.91
3.899	20.9
3.919	20.91
3.939	20.91
3.96	20.91
3.98	20.92
4	20.93

Zeland Software, Inc., IE3D 9.0, Fri May 27 11:33:46 2005
Data File: C:\Documents and Settings\Administrator\Desktop\desktop\newiedd\tyagisachin\patch3.sp

Both Re(Z()) and Im(Z()) in ohm.

Curve-Fitting Scheme: General Intelli-Fit

Freq[GHz]	Re[Z(1,1)]
2	1.59
2.02	1.564
2.04	1.536
2.061	1.507
2.081	1.476
2.101	1.444
2.121	1.41
2.141	1.375
2.162	1.337
2.182	1.298
2.202	1.258
2.222	1.216
2.242	1.174
2.263	1.132
2.283	1.09
2.303	1.053
2.323	1.021
2.343	1.002
2.364	1.003
2.384	1.04
2.404	1.138
2.424	1.343
2.444	1.744
2.465	2.522
2.485	4.076
2.5	6.207
2.505	7.39
2.525	15.22
2.545	38.29
2.566 →	90.75
2.586	123.1
2.606	75.04
2.626	43.41
2.646	28.58
2.667	20.88
2.687	16.42
2.707	13.58
2.727	11.68
2.747	10.32
2.768	9.304
2.788	8.531
2.808	7.925
2.828	7.44
2.848	7.047
2.869	6.724
2.889	6.456
2.909	6.232
2.929	6.045
2.949	5.885
2.97	5.756
2.99	5.648
3	5.602
3.01	5.56
3.03	5.49
3.051	5.438
3.071	5.402
3.091	5.383
3.111	5.381
3.131	5.399
3.152	5.438

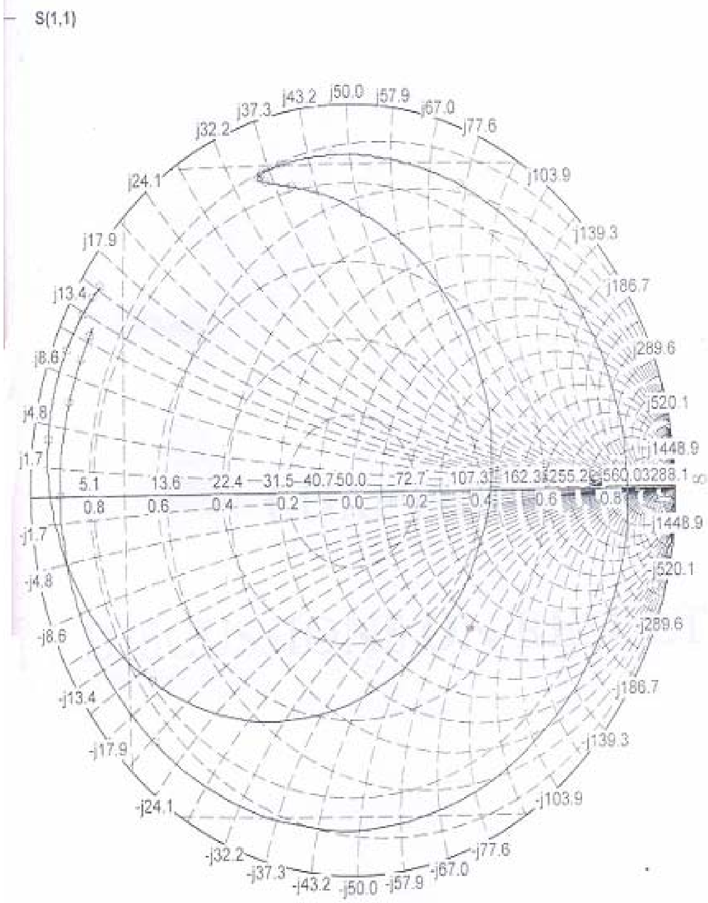
Zeland Software, Inc., IE3D 9.0, Fri May 27 11:33:46 2005
Data File: C:/Documents and Settings/Administrator/Desktop/desktop/vswr/dilipagisachin/patch/

Both Re(Zij) and Im(Zij) in ohm.

Curve-Fitting Scheme: General Intell-Fit

Freq[GHz]	Re(Z(1,1))
3.172	5.496
3.192	5.583
3.212	5.706
3.232	5.871
3.253	6.094
3.273	6.396
3.293	6.812
3.313	7.402
3.333	8.273
3.354	9.643
3.374	12.01
3.394	16.72
3.414	28.82
3.434	82.31
3.455 →	631.1
3.475	55.24
3.495	13.5
3.5	10.64
3.515	6.174
3.535	3.944
3.556	3.076
3.576	2.692
3.596	2.512
3.616	2.428
3.636	2.391
3.657	2.38
3.677	2.381
3.697	2.39
3.717	2.402
3.737	2.415
3.758	2.429
3.778	2.443
3.798	2.456
3.818	2.469
3.838	2.48
3.859	2.491
3.879	2.501
3.899	2.51
3.919	2.518
3.939	2.525
3.96	2.532
3.98	2.538
4	2.544

ocuments and Settings\Admi... 05/27/05 11:4



Information List

ent Reference Mode: Impedence

cted Dot List

No.	Freq	Re(Zs)	Im(Zs)

ference Between Point And Point

dFreq:	dRe(Zs):	dIm(Zs):

tional Information List

CHAPTER- 4

DISCUSSIONS ON RESULTS

DISCUSSIONS ON RESULTS

In this project report we obtained results of simulations for three triangular patches among which one is of IEEE paper by Shan-Cheng Pan and Kin-Lu Wong. All three papers are based on dual frequency operation of antenna. In the paper mentioned above , although dual frequency operations of microstrip patch antennas have received much attention and many related design provide only a moderate frequency ratio(FR)between the two operating frequencies .The reports on dual-frequency operation with FR greater than two are relatively limited .Typical designs that use a single layer, single patch structure and provide large frequency ratio include loading the rectangular microstrip patch with two varactor diodes, short circuiting the rectangular microstrip patch with a shorting pin etc. The former design can provide a dual frequency operation with FR about 5.0 but it needs external circuitry to supply the bias voltage for the diodes , which makes the structure relatively complicated. As for latter , the structure is much simpler and requires only proper selection of the shorting pin position in the microstrip patch .Moreover, the impedence matching for operating at the two frequencies can be achieved using a single probe feed . The reported FR for such a design using a rectangular patch is tunable in the range 2.0-3.2 and from the study on compact triangular microstrip antennas that use a similar shorting pin technique, which shows a greater resonant frequency reduction that the rectangular or circular patches, it is expected that the tunable FR range can also be greater for a triangular patch than from a rectangular one. This motivates the present study. The design for a dual-frequency triangular microstrip antenna with shorting pin is described and typical experimental results are presented.

All design dimensions are in mm

For all designs of triangular patch : h= Z_{top} = 1.6, ϵ_r =4.4

Radius of shorting pin = r_s = 0.32, radius of probe = r_p = 0.63

Length of side of equilateral triangle ABC = d =50

Co-ordinates of point A(0,43.30) , B(-50,0) , C(50,0)

Probe position (P_x , P_y) = (0 , 40.47) is fixed in all designs.

Design 1 : For this design(of paper mentioned abov e)

Position of shorting pin = (Sx , Sy) =(0,42.95), ds=42.95mm

Results : Results obtained are exact relevant to the paper .

Design 2 : Position of shorting pin =(Sx , Sy) =(0,14.433) ,ds=14.43mm

Result : Results are relevant to the theory.

Design 3 : Position of shorting pin =(Sx , Sy) =(0,7.22) , ds=7.22mm

Result : Results are relevant to the theory.

CONCLUSION : For a first design a dual frequency triangular microstrip antenna design with tunable frequency ratio of the two operating frequencies in the range about 2.5- 4.9 has been presented .Experimental results for operating at frequencies 464 & 2276 MHz are also shown. Due to its large tunable frequency ratio ,the present design of using a short- circuiting triangular patch can find applications in systems where dual frequency design with a large frequency ratio is needed ,for instance , in synthetic aperture radar(SAR) systems.

Similarly for design 2 & design 3 tunable range can be calculated.

CHAPTER-5

IE3D SOFTWARE

IE3D SOFTWARE

IE3D is an integrated full-wave electromagnetic simulation and optimization package for the analysis and design of 3-dimensional microstrip antennas and high frequency printed circuits and digital circuits, such as microwave and millimeter wave integrated circuits(MMICS) and high speed printed circuit boards(PCB)

IE3D has been adopted as an industrial standard in planar and 3-dimensional electromagnetic simulation. It is technology for electromagnetic simulation to yield high accuracy analysis and design of complicated microwave and RF printed circuit, antennas, high speed digital circuits and other electronic components.

The IE3D has become the most versatile ,easy to use, efficient and accurate electromagnetic simulation tool.

IE3D application programs and capability

The IE3D package consists of the following major application programs:

- **MGRID**:- Layout editor for the construction of a geometery,and post processor for current display and pattern calculation
- **IE3D**:-Electromagnetic simulator or simulation engine for numerical analysis.
- **MODUA**:-Schematic editor for parameter display and nodal circuit simulation.
- **PATTERNVIEW**:-Post processor for radiation patterns.
- **IE3D LIBRARY**:- The object oriented 2nd IE3D interface for parameterized geometry construction.
- **CURVIEW**:-Post processor for display of current distribution and field distribution.

FURTHER SCOPE OF STUDY

In this project work desired tuning range is obtained for the first design which can be achieved for the other two designs by varying the position of shorting pin or large tuning range with more bandwidth can be achieved by varying the position of probe and
Shorting pin for broadband case. Due to large tunable range the present designs of using a short circuited triangular patch can find applications in the systems where frequency designs with large frequency range is needed , for instance, in synthetic aperture radar (SAR) systems. Thus obtained design can go for hardware implementation

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BIBLIOGRAPHY

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