New Multiband E-Shape Microstrip Patch Antenna on RT DUROID 5880 Substrate and RO4003 Substrate for Pervasive Wireless Communication

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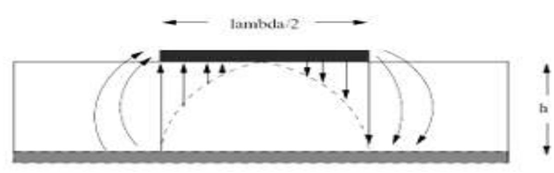
ABSTRACT
The area of micro strip antennas has seen some inventive work in recent years and is currently one of the most dynamic fields of antenna theory. An overview of work done in the area of micro strip antennas is presented and several recent developments in the field are highlighted. In addition, new antenna configurations that improve electrical performance and manufacturability are described. This designing is very easy and chip in microstrip antenna designing. We analyzed micro strip antenna in IE3D by finite moment of method. The proposed antenna design on different substrate and analyzed result of both substrates between 1GHz to 20GHz,When the proposed antenna design on a 31 mil RT DUROID 5880 substrate from Rogers-Corp with dielectric constant of 2.2 and loss tangent of .004. At 14GHz the verify and tested result on IE3D SIMULATOR are Return loss = -10.35dB, VSWR=1.872, Directivity=6dbi, Z=32.94Ω Characteristic impedance, and when The proposed antenna design on a 60 mil RO4003 substrate from Rogers-Corp with dielectric constant of 3.4 and loss tangent of .002. At 10GHz the effective results of RO4003 substrate verify and tested on IE3D SIMULATOR are Return loss = -21.34dB, VSWR=1.192, Directivity=8dbi, Z=42.31Ω Characteristic impedance, Axial ratio (at theta=90deg) =96%. The optimum 60 mil RO4003 substrate E Shape microstrip patch antenna provides very good results between 10GHz to 20GHz, All results shown in Simulation results. The results shown in Table 1, Table2,

Keywords
Micro strip antenna, IE3D SIMULATOR, Dielectric, Patch width, Patch Length, Characteristic Impedance, Losses, strip width, strip length

1. INTRODUCTION
A A Deshmukh and G Kumar [9] proposed compact L Shape patch broadband Microstrip antenna experimentally increase bandwidth up to 13.7%. Z M Chen [14] further increase bandwidth of this antenna up to 23.7% - 24.4%. J George [3] proposed optimal angle between feed line and patch for enhancing bandwidth. K F Lee [14] proposed U Shape slot shorting post small size Microstrip Antenna and increase bandwidth up to 42%. Z M chen Tsai K F Lee [14] [13] used low permittivity in proposed design for enhancing Bandwidth. R Garg P Bharti [10] significant increasing in bandwidth by increasing height of dielectric material. Latif S I Shafai [2] enhances gain and bandwidth by novel technique form ring by depositing multiple conductor layer separated by laminating dielectric. S C Gao [8] used uniplanar photonic band gap structure for enhancing band width and gain. M Khodier[11] New wideband stacked microstrip antennas for enhancing band width. W. S. Yun, Wideband microstrip antennas for PCS/IMT-2000 services. Major issue for microstrip antenna is narrow Bandwidth. Our proposed 31 mil RT DUROID 5880 substrate E shaped antenna provides optimum results at 14GHz VSWR is 1.872 and return loss is -10.35dB. and proposed 60 mil RO4003 substrate E shaped antenna provide optimum results between 10GHz –20GHz. at 10GHz VSWR is 1.192 and return loss is -21.34dB.The results of proposed E-Shaped Multiband microstrip patch antenna verified in IE3D Simulator .All results shown in simulation result..We find mathematical analysis of micro strip given below

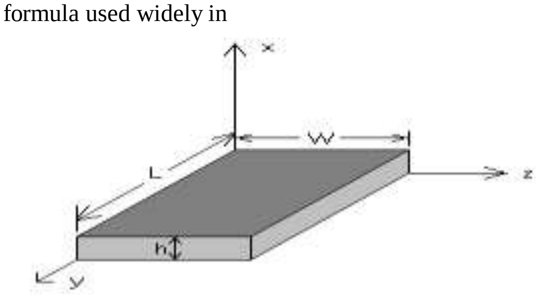


Side view of the microstrip antenna.

Figure 1

EFFECTIVE PARAMETERS

The electric field radiated from a micro strip antenna meets a boundary between two different dielectrics: air and the substrate material. Because of the slight distortion of the field at the boundary, the patch can appear longer in an electrical sense. Thus we have an effective patch length. There is also an effective relative permittivity when performing micro strip antenna analysis. The effective relative permittivity can be calculated by this formula used widely in



E-plane pattern

$$E_{\Phi} = \frac{kV_0 w}{2\pi r} e^{-jkr} \left[\sin\theta \left(\frac{\sin\left(\frac{kw}{2}\cos\theta\right)}{\frac{kw}{2}\cos\theta} \right) \right]$$

H-plane pattern

$H_{\theta} = E_{\Phi}/\eta$

Characteristic impedance of microstrip line feed for w/h ≤ 1

$$Z_0 = \frac{60}{\sqrt{\varepsilon_{reff}}} \ln\left[\frac{8h}{w} + \frac{w}{4h}\right]$$

for w/h ≥1

$$Z_0 = \frac{120\pi}{\sqrt{\varepsilon_{reff}} \left[\frac{w}{h} + 1.393 + .667 \ln\left(\frac{w}{h} + 1.44\right) \right]}$$

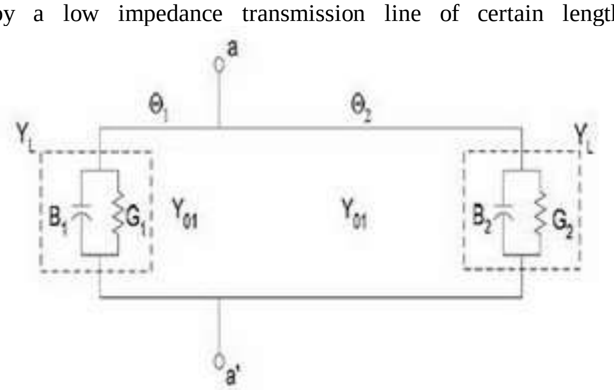
Beam widths E-***plane***

$$\theta_E \cong 2\cos^{-1}\sqrt{\frac{7.03\lambda 0^2}{4\left(3Le^2 + h^2\right)\pi^2}}$$

H-plane

$$\theta_H \cong 2\cos^{-1}\sqrt{\frac{1}{2+kw}}$$

Transmission line method is the easiest method as compared to the rest of the methods. This method represents the rectangular micro strip antenna as an array of two radiating slots, separated by a low impedance transmission line of certain length.



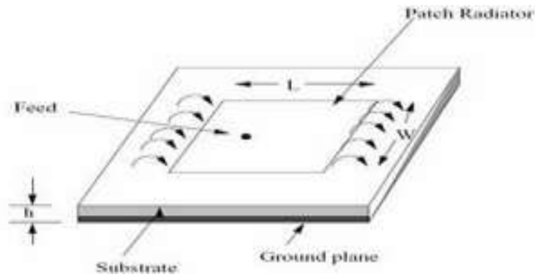


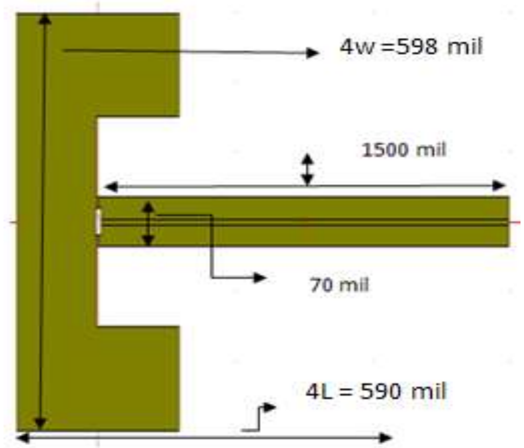
Figure 2

The above Figure 3 shows a patch antenna from the Transmission Line Model perspective. We can observe the fringing at the edges increasing the effective length.

$$\varepsilon_{reff} = \frac{(\varepsilon r - 1)}{2} + \frac{(\varepsilon r + 1)}{2} \left(1 + 10\frac{h}{w}\right)^{-1/2}$$

$$w = \frac{c}{2fr}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

2. PROPOSED ANTENNA AT 14GHz ON 31 mil RT DUROID 5880 substrate



The Proposed antenna has:-

Proposed Patch length = 4L

Proposed Patch Width = 4W

Strip Path Length= 1500miles

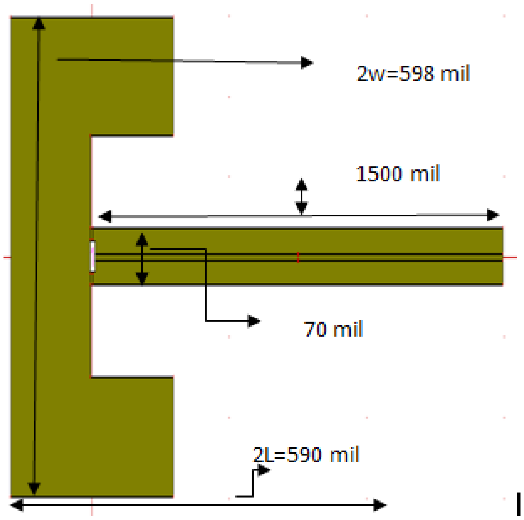
Strip Path Width= 70miles

Cut width =300miles

Cut depth = 300 miles

$$w = \frac{c}{2fr}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

PROPOSED ANTENNA AT 10GHz 60 mil RO4003 substrate



The Proposed antenna has:-

Proposed Patch length = 2L

Proposed Patch Width = 2W

Strip Path Length= 1500miles

Strip Path Width= 70miles

Cut width =300miles

Cut depth = 300 miles

SIMULATED MICROSTRIP PATCH ANTENNA IN IE3D SIMULATOR FOR 31 mil RT DUROID 5880 SUBSTRATE AND 60 mil RO4003 SUBSTRATE

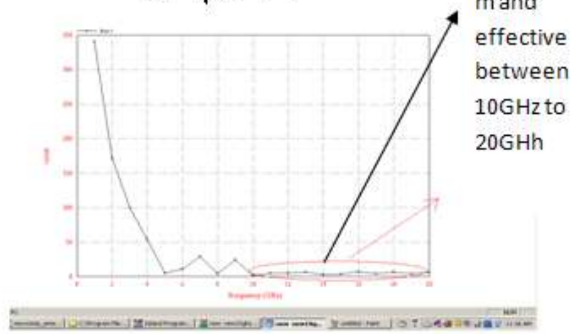
(1) VSWR VS FREQUENCY (IN GHz)

(a) RT DUROID 5880 substrate

For proposed design the value of VSWR is effective between 14GHz to 20GHz, for this value return loss is minimum. At 14GHz return loss is -10.35dB and VSWR is 1.872, At 7GHz VSWR is 3.581, At 12GHz VSWR is 4.712, at 15GHz VSWR is 5.197, at 17GHz VSWR is 7.404, at 18GHz VSWR is 3.931, at 20GHz VSWR is 5.683

(b) RO4003 substrate

$$w = \frac{c}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

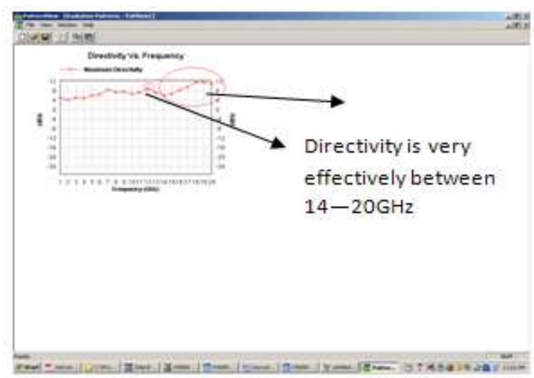


For proposed design the value of VSWR is very effective between 10GHz to 20GHz, for this value return loss is minimum. At 10GHz return loss is -21.34dB and VSWR is 1.192, At 14GHz VSWR is 2.678, At 15GHz VSWR is 3.013, at 8GHz VSWR is 3.7, at 19GHz VSWR is 3.686, at 5GHz VSWR is 4.468

(2) *Directivity VS FREQUENCY (IN GHz)*

(a) RT DUROID 5880 substrate

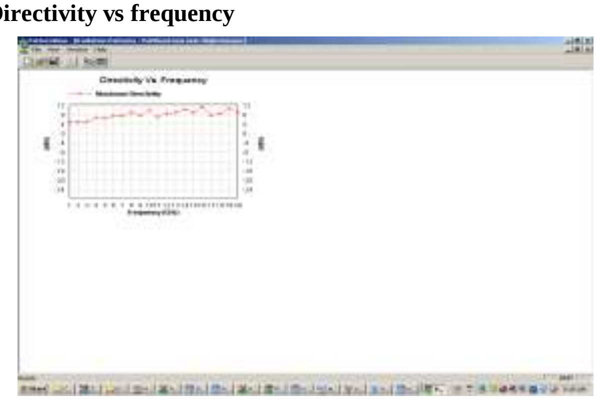
Directivity vs frequency



At 14 GHz Directivity is 6dBi,between 18—20GHz Directivity is 11dBi,at 17GHz Directivity is 9dBi,

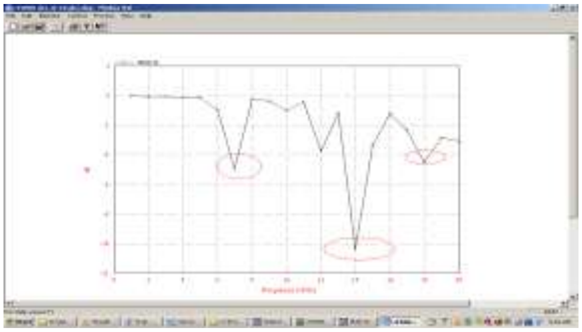
(b) RO4003 substrate

Directivity vs frequency



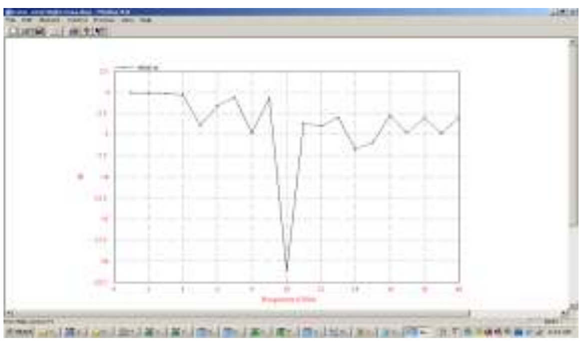
(3) Return loss VS Frequency (in GHz)

(a) <u>RT DUROID 5880 substrate</u>



The frequency at 7GHz return losses is -4.983, at 12GHz return losses is -3.744, at 14GHz return losses reduce very significantly -10.35, at 15GHz return loss is -3.385, at 18 GHz return loss is -4.519

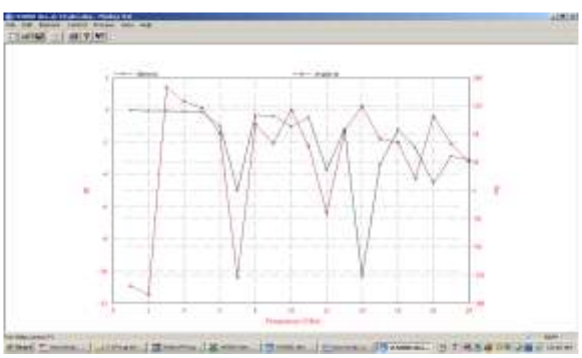
(b) <u>RO4003 substrate</u>



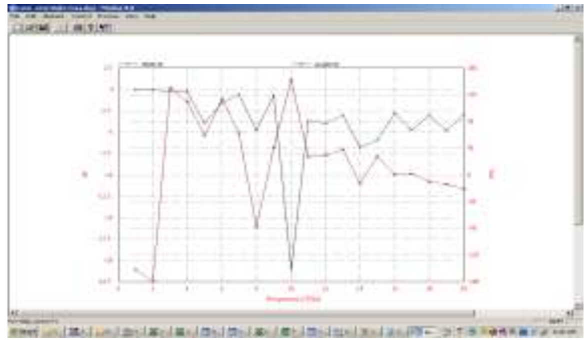
The frequency at 5GHz return losses is -3.955, at 8GHz return losses is -4.789, at 10GHz return losses reduce very significantly -21.34, at 14GHz return loss is -6.816,at 15 GHz return loss is -5.992

(4) <u>S Parameter (magnitude in db and phase) VS Frequency in GHz</u>

(a) <u>RT DUROID 5880 substrate</u>

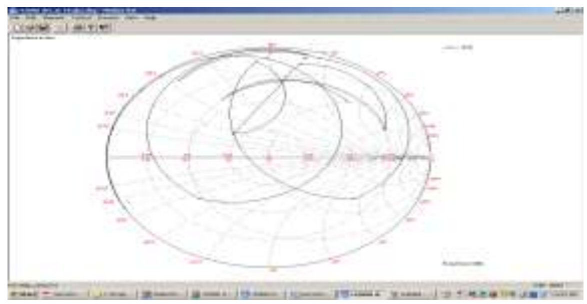


(b) <u>RO4003 substrate</u>

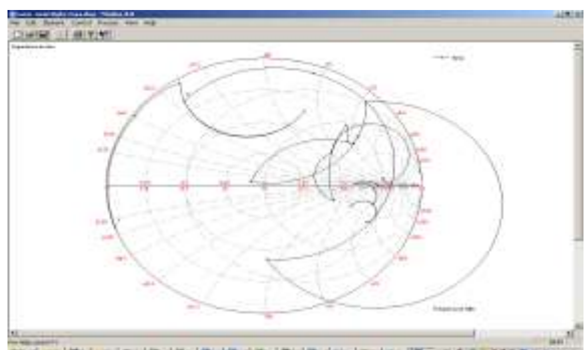


(5) SIMTH CHART FOR DIFFERENT MEASURMENT

(a) <u>RT DUROID 5880 substrate</u>

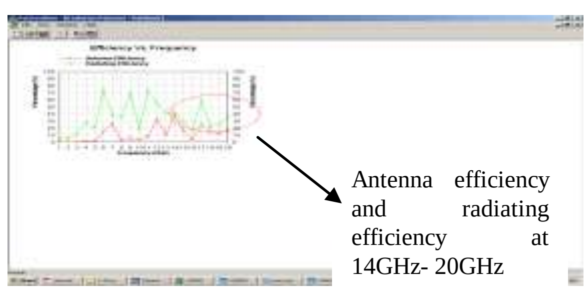


(b) <u>RO4003 substrate</u>



(6) (Antenna Efficiency and Radiating Efficiency) VS (Frequency in GHz)

(a) <u>RT DUROID 5880 substrate</u>



(b)

RO4003 substrate

Gain vs frequency

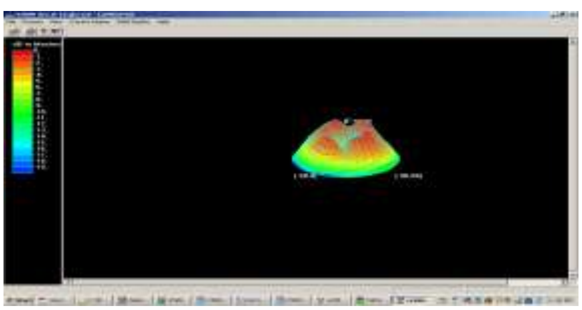
(7) Radiation Pattern:-

(i) RT DUROID 5880 substrate

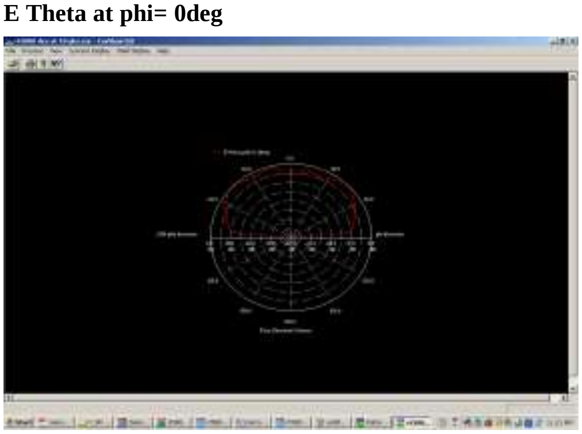
Study of different Azimuth pattern and Elevation pattern in IE3D .Analyzed radiation characteristic of antenna at 10 GHz shown in figure

(a) Elevation Pattern

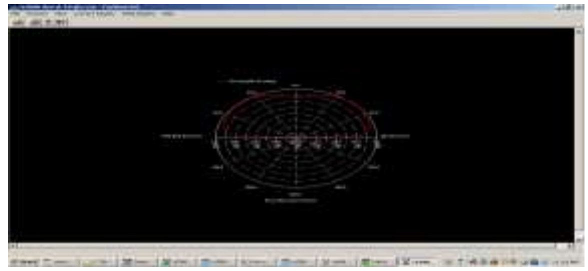
Elevation Pattern of E maximum,



E Theta at phi= 0deg



Elevation Pattern of E Total at phi =90(deg)

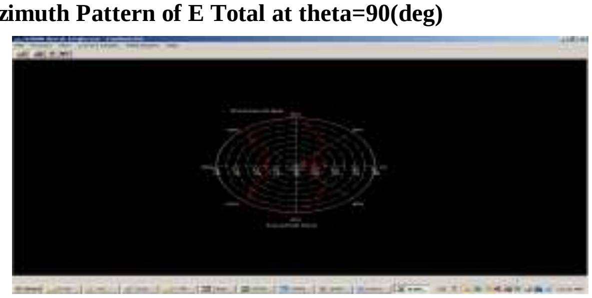


Elevation Pattern of E Total, E Right, E left, E theta, E Phi at phi=90 (deg)

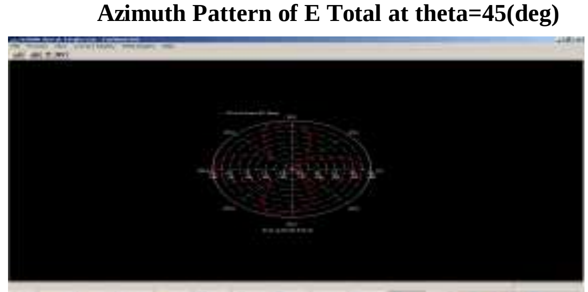
(b) Azimuth Pattern

Azimuth Pattern at E theta, theta=0(deg)

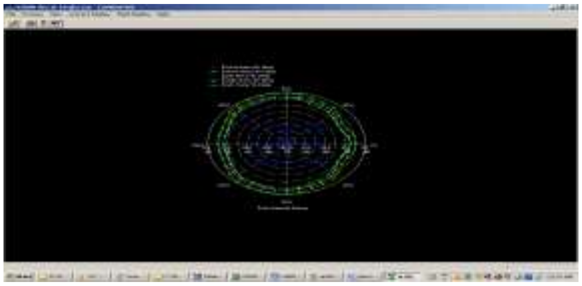
Azimuth Pattern of E Total at theta=90(deg)



Azimuth Pattern of E Total at theta=45(deg)



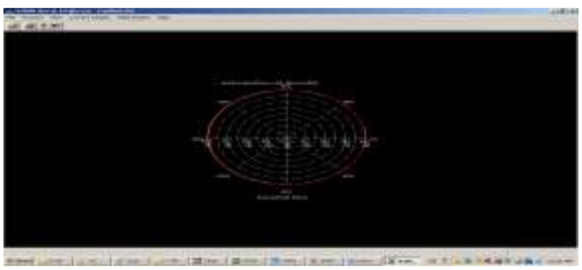
Azimuth Pattern of E Total, E Right, E left, E theta, E Phi at theta=90(deg)



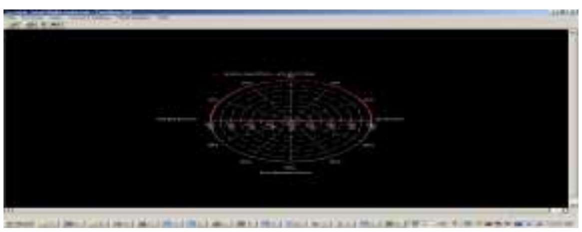
(8)AXIAL RATIO PATTERN

(A) FOR AZIMUTH PATTERN

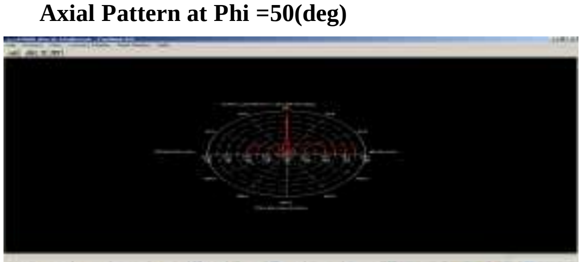
Axial Pattern at theta=0(deg)



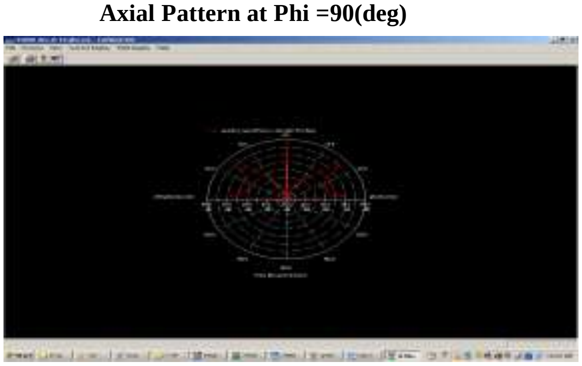
(B)FOR ELEVATION PATTERN



Axial Pattern at Phi =50(deg)

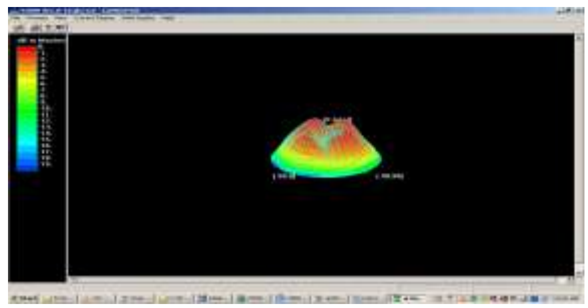


Axial Pattern at Phi =90(deg)

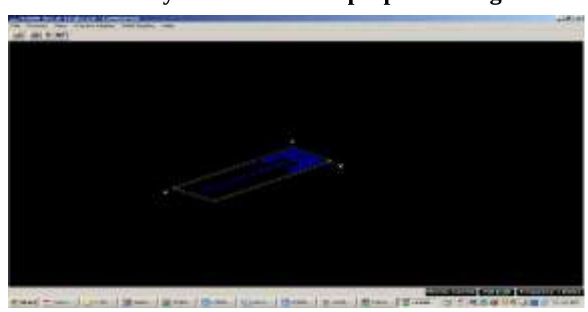


Axial ratio vs. Frequency

3D Elevation Pattern at 90 deg



Current density distribution for proposed design



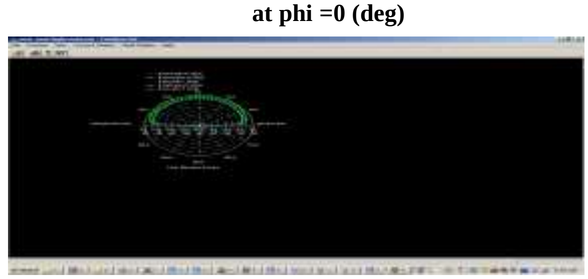
Radiation Pattern

(ii) RO4003 substrate

Study of different Azimuth pattern and Elevation pattern in IE3D .Analyzed radiation characteristic of antenna at 10 GHz shown in figure

(a) Elevation Pattern

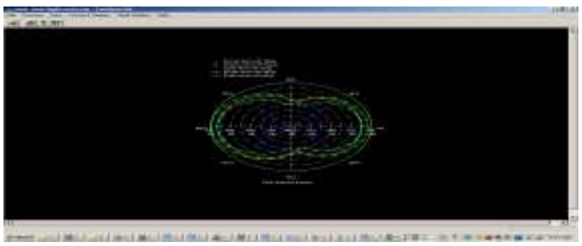
Elevation Pattern of E Total, E Right, E left, E theta, E Phi at phi =0 (deg)



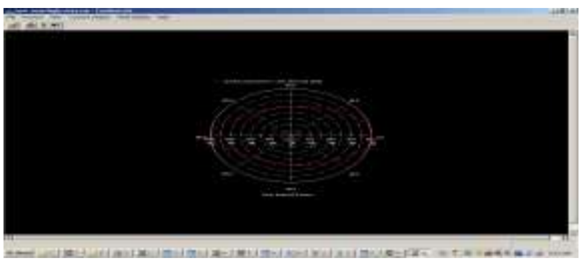
Elevation Pattern of E Total, E Right, E left, E theta, E Phi at phi=90 (deg)

(b) Azimuth Pattern

Azimuth Pattern of E Total, E Right, E left, E theta, E Phi at theta=90(deg)

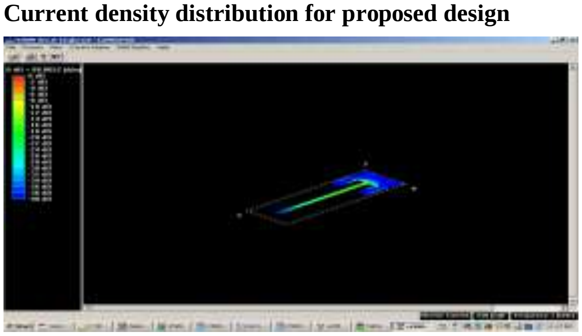


Axial Ratio pattern at theta =20(deg)



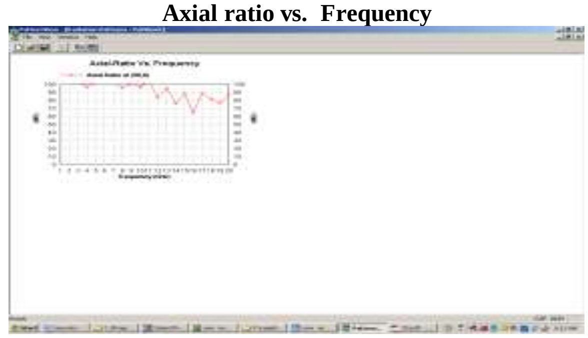
Azimuth Pattern at theta=90(deg)

Current density distribution for proposed design



(b) RO4003 substrate

Axial ratio vs. Frequency



Axial ratio at 10GHz is 96% verify in IE3D SIMULATOR

Simulation Table:-

Table -1 dB [S (i j)] in dB and Ang[S (i j)] in Deg

Freq [Ghz]	dB[S(1,1)] 31 mil RT DUROID 5880 substrate	dB[S(1,1)]__60 mil RO4003 substrate
1	$-2.912e^{-0.02}$	$-5.1e^{-0.02}$
2	$-5.98e^{-0.02}$	-0.1011
3	$-6.412e^{-0.02}$	-0.1752
4	-0.1106	-0.3228
5	-0.1389	-3.955
6	-0.9716	-1.604
7	-4.983	-0.6102
8	-0.3035	-4.789
9	-0.3481	-0.7328
10	-1.037	-21.14
11	-0.4362	-3.673
12	-3.744	-4.01
13	-1.181	-3.038
14	-10.35	-6.816
15	-3.385	-5.992
16	-1.22	-2.819
17	-2.361	-4.79
18	-4.519	-3.06
19	-2.868	-4.833
20	-3.089	-2.95

Table -2 Frequency (GHz) vs. VSWR (MEASUREMENT BY IE3D SIMULATOR)

Frequency [GHz]	VSWR 31 mil RT DUROID 5880 substrate	VSWR 60 mil RO4003 substrate
1	596.5	340.6
2	290.5	171.8
3	270.9	99.18
4	157.1	53.83
5	125.1	4.468
6	17.9	10.68
7	3.581	28.48
8	57.24	3.719
9	49.91	23.72
10	16.77	1.192
11	39.83	4.8
12	4.712	4.409
13	14.73	5.776
14	1.872	2.678
15	5.197	3.013
16	14.26	6.215
17	7.404	3.718
18	3.931	5.736
19	6.111	3.686
20	5.683	5.946

CONCLUSION

Microstrip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. One limitation is their inherently narrow bandwidth. However, recent studies and experiments have found ways of overcoming this obstacle. A variety of approaches have been taken, including modification of the patch shape, experimentation with substrate parameters, Most notably mobile communication systems where many frequency ranges could be accommodated by a single antenna. We here design simple and low costlier patch antenna for pervasive wireless communication by using different substrate. The transmission line model seems to be the most instructive in demonstrating the bandwidth effects of the changing the various parameters. When the proposed antenna design on a 31mil RT DUROID 5880 substrate from Rogers-Corp with dielectric constant of 2.2 and loss tangent of .004. The proposed antenna has four times patch length, four times patch width and more feed line length. The proposed frequency range 14GHz (Ku Band) and Analysis Radiation Characteristics of micro strip Antenna by IE3D Simulator. The results of proposed designing are effective between 14GHz-20GHz. proposed antenna simulated in IE3D Simulator. The optimum results of proposed antenna verify and tested in IE3D SIMULATOR. The simulated results of IE3D at 14GHz is Return loss = -10.35db, VSWR = 1.872, Directivity =8dbi. The proposed 31mil RT DUROID 5880 substrate E-Shaped multiband microstrip antenna effective work on 7GHz, 12GHz, at 14GHz (Ku Band) the proposed antenna work very effectively for pervasive wireless communication. When the proposed antenna design on a 60mil RO4003 substrate from Rogers-Corp with dielectric constant of 3.4 and loss tangent of .002. The proposed frequency range 10GHz (X Band) and Analysis Radiation Characteristics of micro strip Antenna by IE3D Simulator. The proposed antenna has double patch length, patch width and more feed line length. The results of proposed designing are very effective between 10GHz-20GHz. proposed antenna simulated in IE3D Simulator. The optimum results of proposed antenna verify and tested in IE3D SIMULATOR. The simulated results of IE3D at 10GHz is Return loss = -21.34db, VSWR = 1.192, Directivity =8dbi. Axial ratio is 96%. The proposed 60mil RO4003 substrate E-Shaped multiband microstrip antenna effective work on 5GHz, 8GHz, and between (10GHz—20GHz) Band for pervasive wireless communication.

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