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# E-Shape Microstrip Patch Antenna for Pervasive Wireless Communication at 14GHz (Ku Band)

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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 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, 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

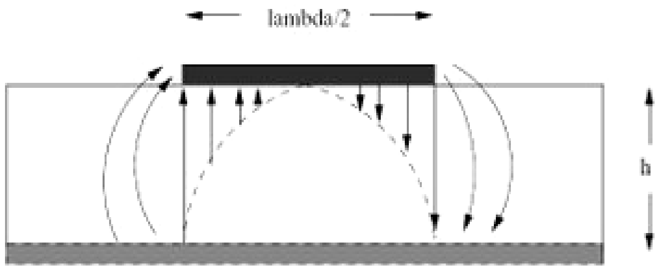
## Introduction to Microstrip Antenna

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 micro-strip antenna is narrow Bandwidth. Our proposed E shaped antenna provide optimum results at 14GHz VSWR is 1.872 and return loss is -10.35dB.The results of proposed E-Shaped Multiband micro-strip patch antenna verified in IE3D Simulator .All results shown in simulation result..We find mathematical analysis of micro strip given below

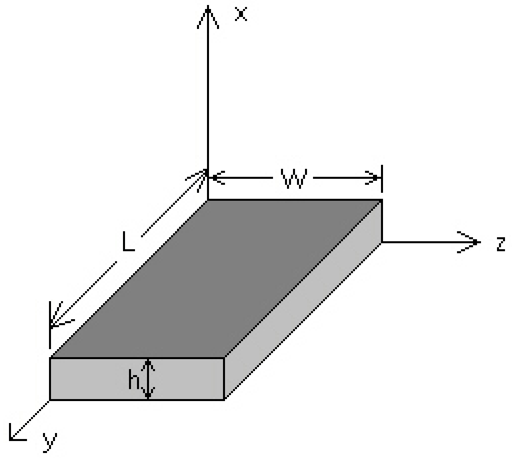



Side view of the microstrip antenna.

**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

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

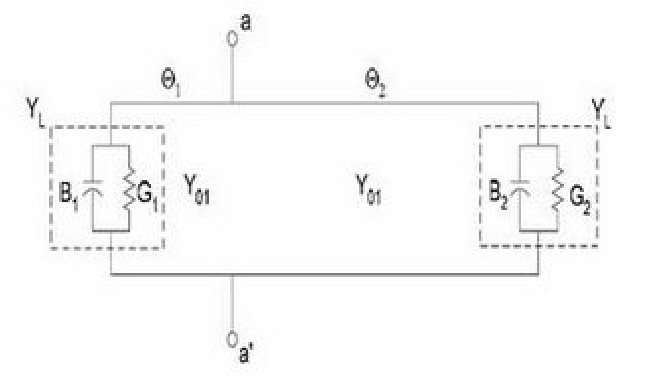
**Beam widths E**-plane

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

**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.




The following effects are taken into account for this model:
**Fringing Effects:** As the dimensions of the patch are finite along the length and the width, the fields at the edges of the patch undergo fringing i.e. the field exists outside the dielectric thus causing a change in the effective dielectric constant. It is a function of the dimensions of the patch and the height of the substrate.

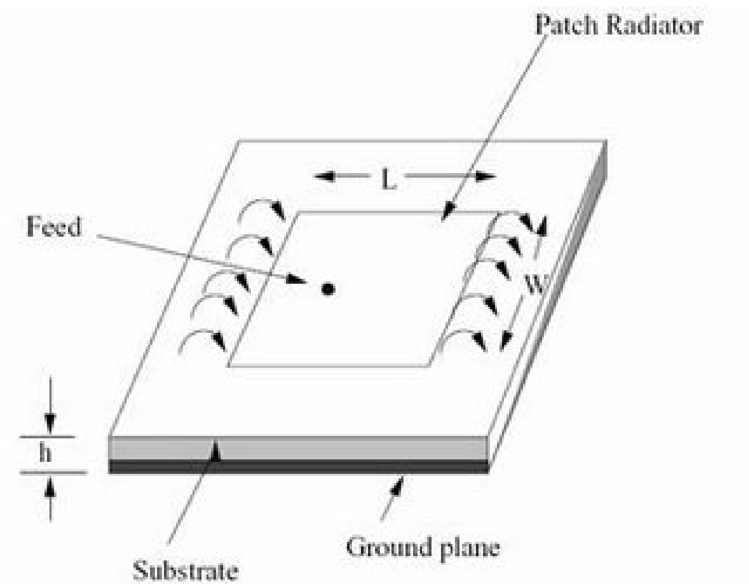


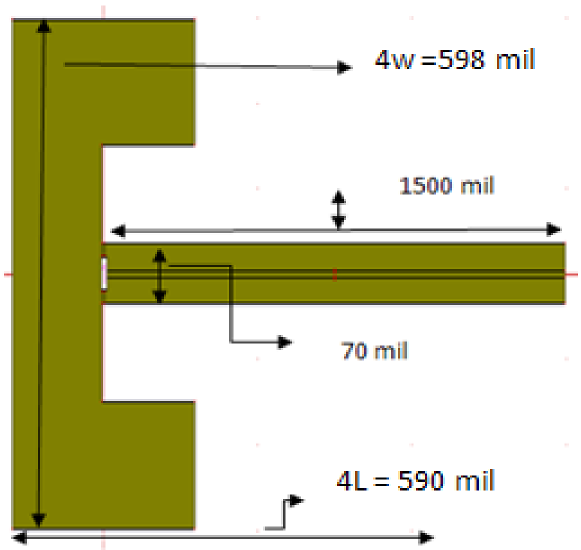

**Figure 2**

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.

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

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

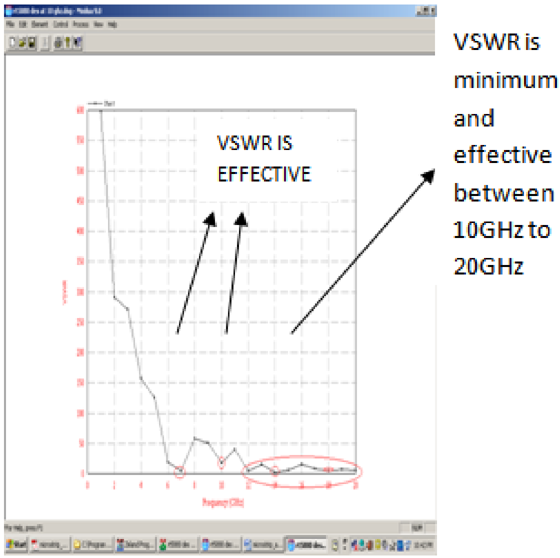
## Proposed Antenna at 14GHz



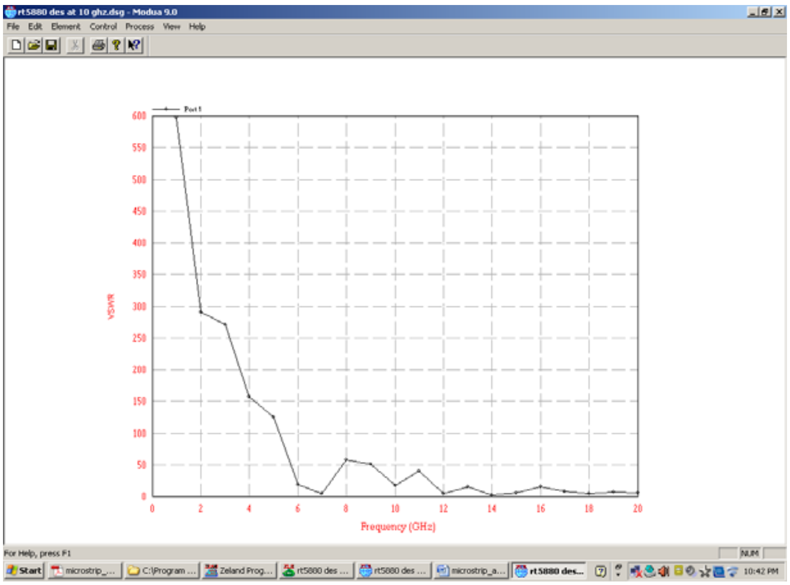

**The Proposed antenna has:**
Proposed Patch length = 4L
Proposed Patch Width = 4W
Strip Path Length= 1500miles
Strip Path Width= 70miles
Cut width =300miles
Cut depth = 300 miles

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

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

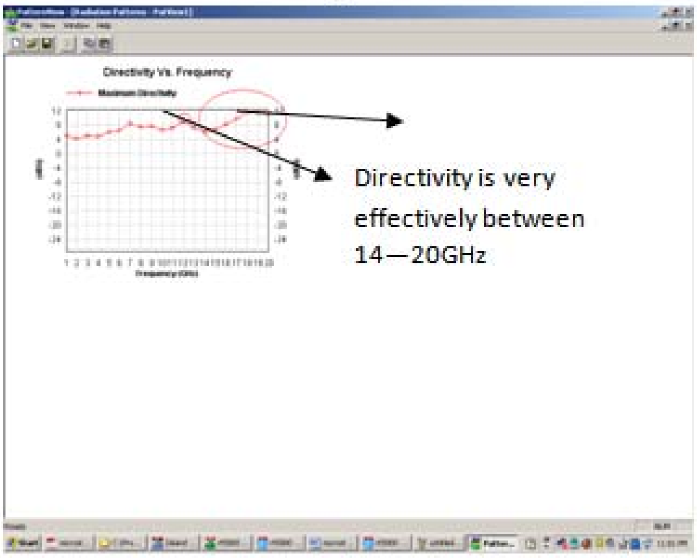



**Simulated Microstrip Patch Antenna in IE3D VSWR vs Frequency (IN GHz)**



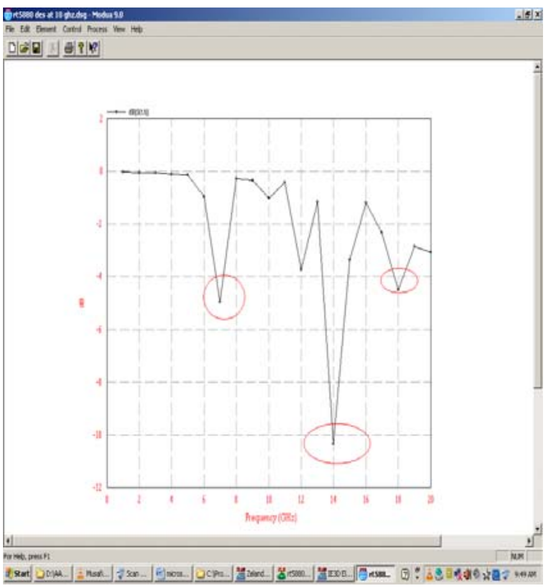

For proposed design the value of VSWR is effective between 14GHz to 20GHz, for this value return loss is minimum. At 14GHz return loss is -10.35dB and VSWR is 1.872, At 7GHz VSWR is 3.581, At 12GHz VSWR is 4.712, at 15GHz VSWR is 5.197, at 17GHz VSWR is 7.404, at 18GHz VSWR is 3.931,at 20GHz VSWR is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

**Directivity vs Frequency (IN GHz)**



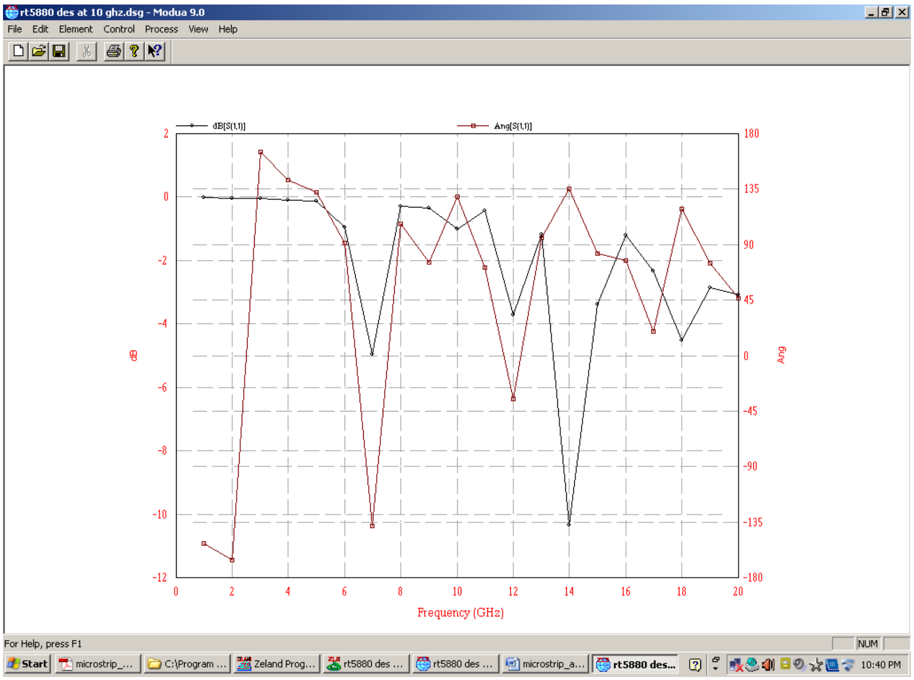

At 14 GHz Directivity is 6dBi,between 18—20GHz Directivity is 11dBi,at 17GHz Directivity is 9dBi,

**Return loss VS Frequency (in GHz)**

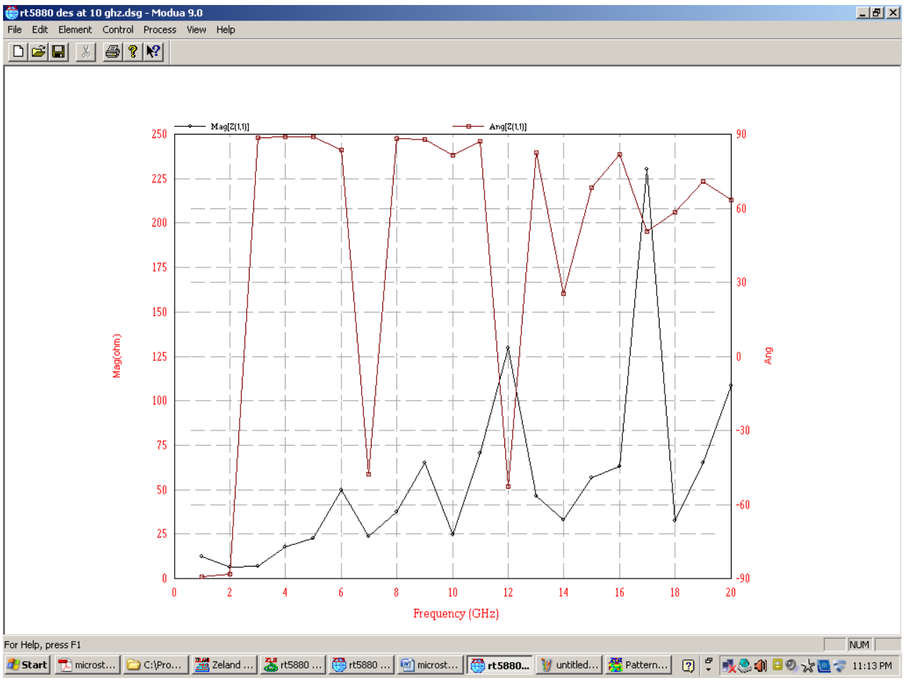


The frequency at 7GHz return losses is -4.983, at 12GHz return losses is -3.744, at 14GHz return losses reduce very significantly -10.35, at 15GHz return loss is -3.385, at 18 GHz return loss is -4.519

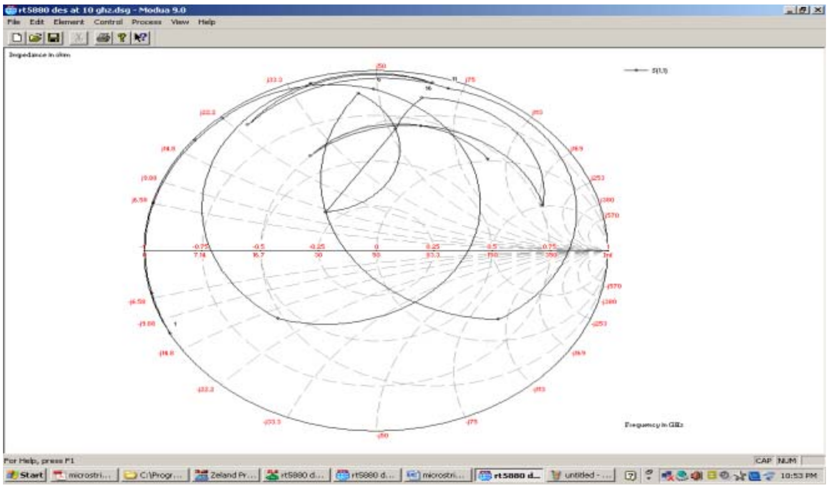
**S Parameter (magnitude in db and phase) VS Frequency in GHz**



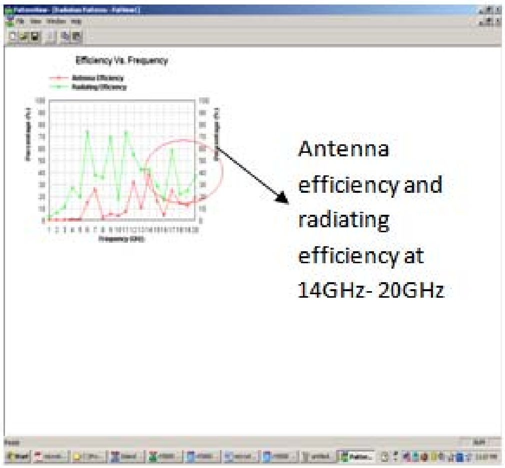

**Magnitude and phase of Z Parameters VS Frequency in GHz**

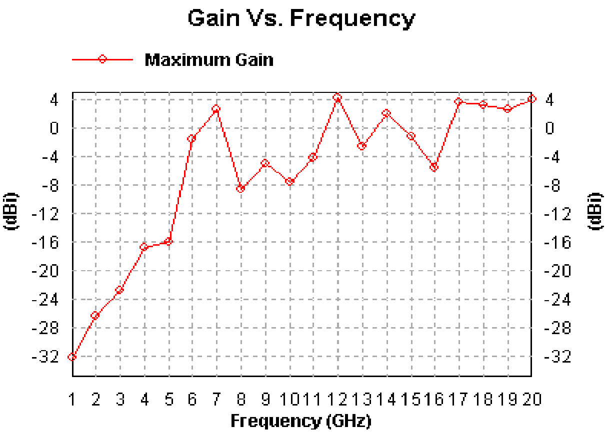


## SIMTH CHART FOR DIFFERENT MEASURMENT



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



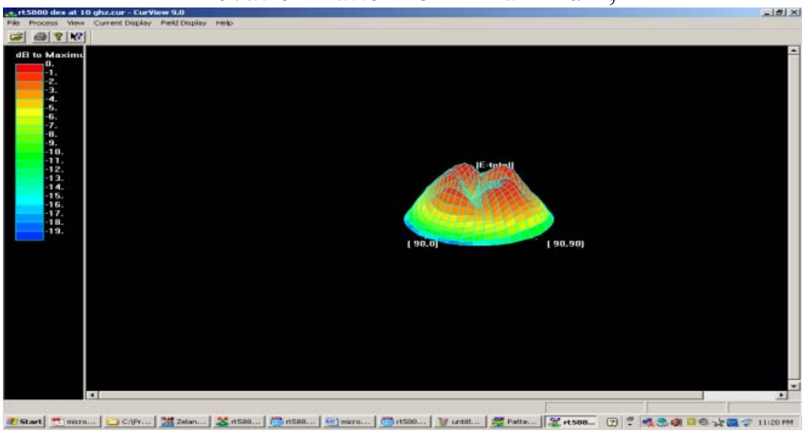



**Radiation Pattern**

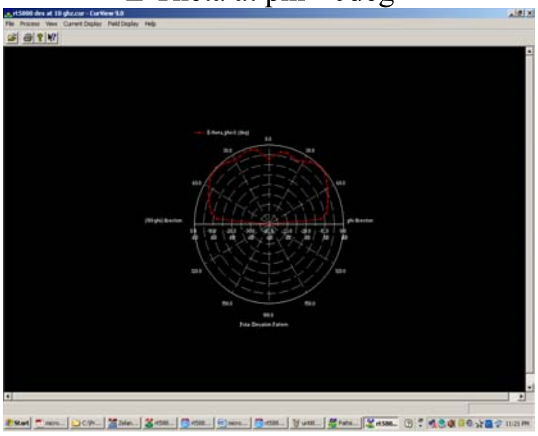
Study of different Azimuth pattern and Elevation pattern in IE3D .Analyzed radiation characteristic of antenna at 10 GHz shown in figure

**Elevation Pattern**

Elevation Pattern of E maximum,

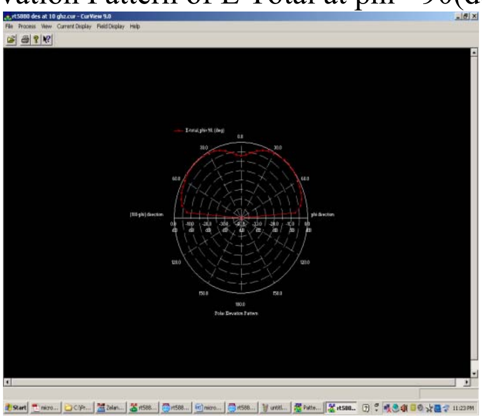


E Theta at phi= 0deg

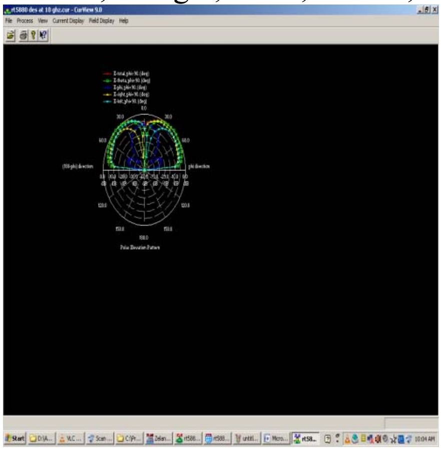


a

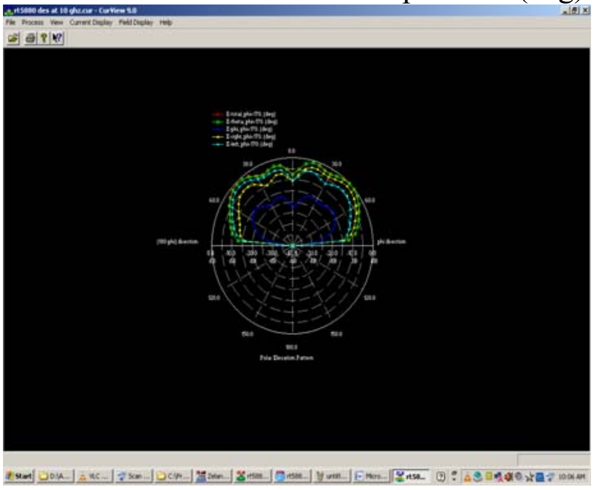
Elevation Pattern of E Total at phi =90(deg)



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

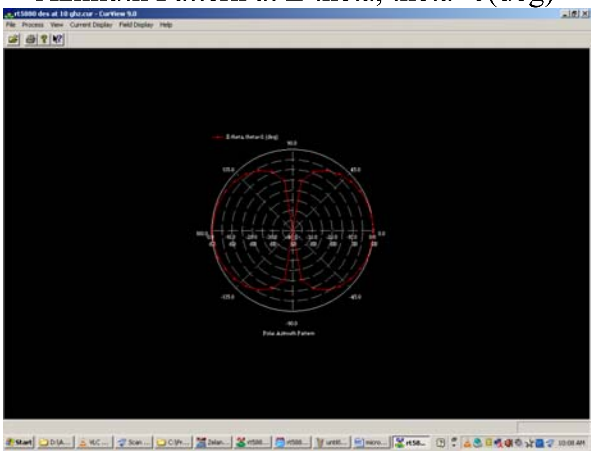


Elevation Pattern of E Total at phi =170(deg)

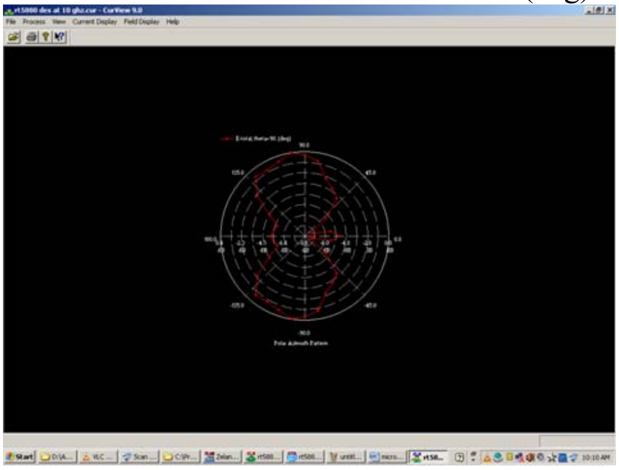


**Azimuth Pattern**

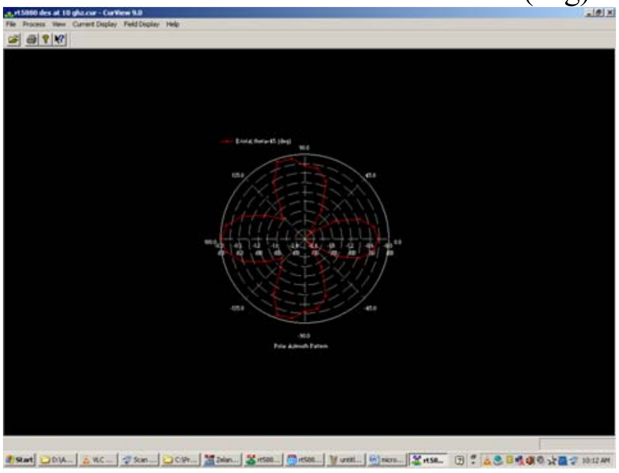
Azimuth Pattern at E theta, theta=0(deg)



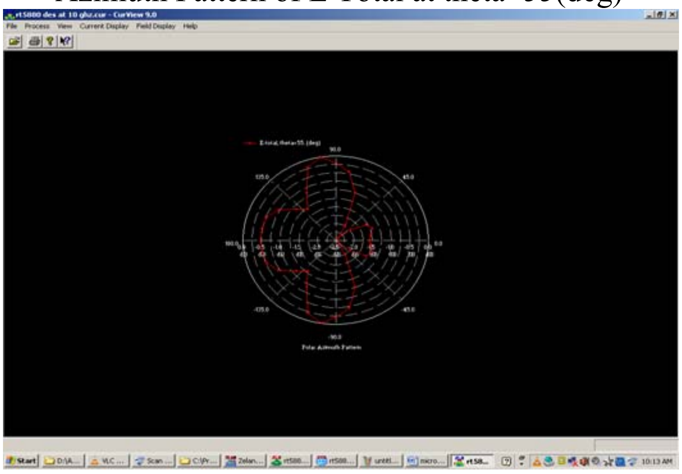
Azimuth Pattern of E Total at theta=90(deg)



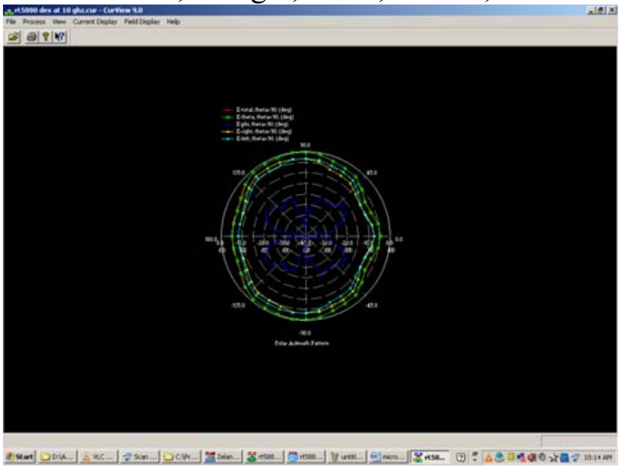
Azimuth Pattern of E Total at theta=45(deg)



Azimuth Pattern of E Total at theta=55(deg)

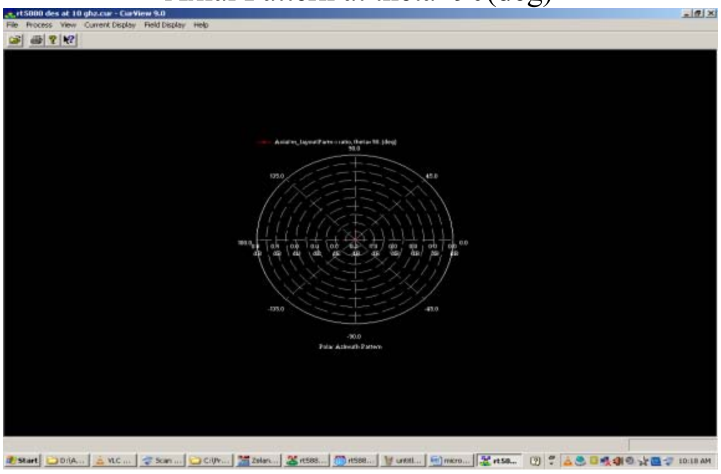


Azimuth Pattern of E Total, E Right, E left, E theta, E Phi at theta=90(deg)

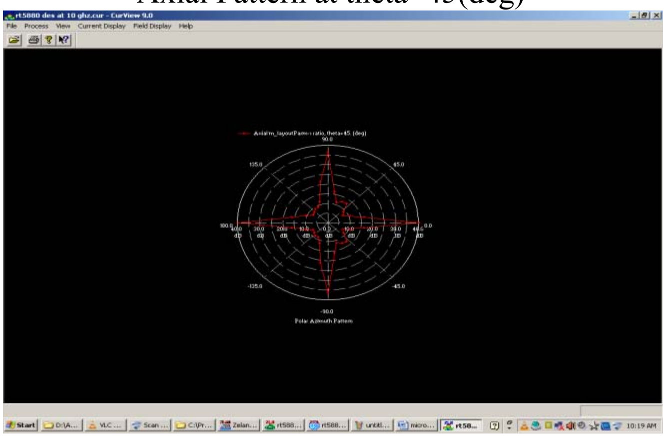



**Axial Ratio Pattern**
**For Azimuth Pattern**

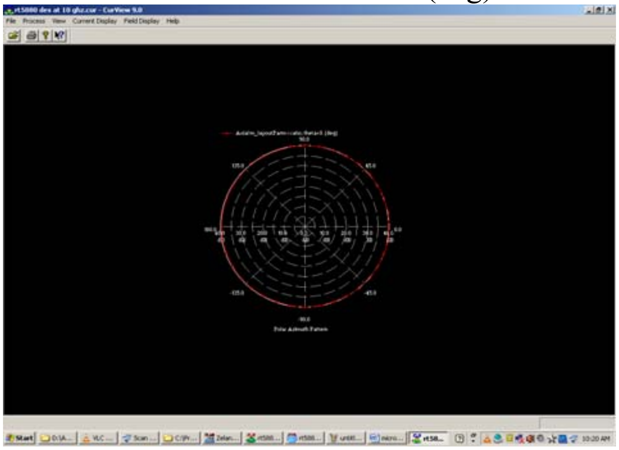
Axial Pattern at theta=90(deg)




Axial Pattern at theta=45(deg)

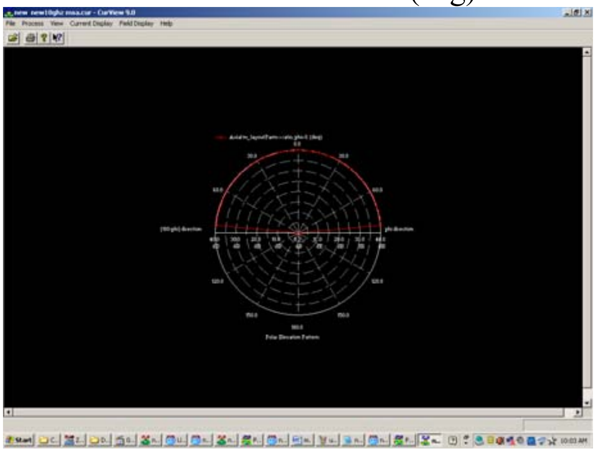


Axial Pattern at theta=0(deg)

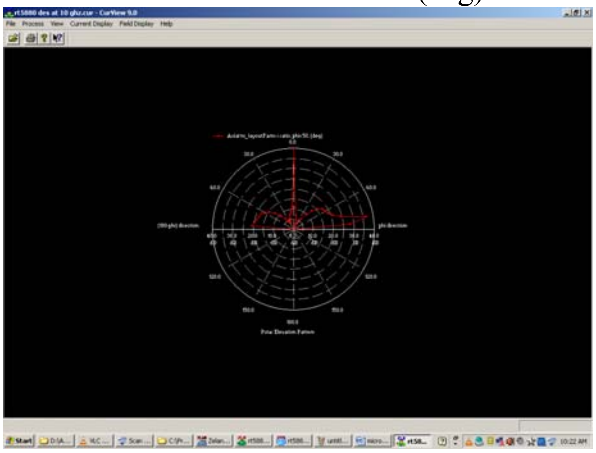


**For Elevation Pattern**

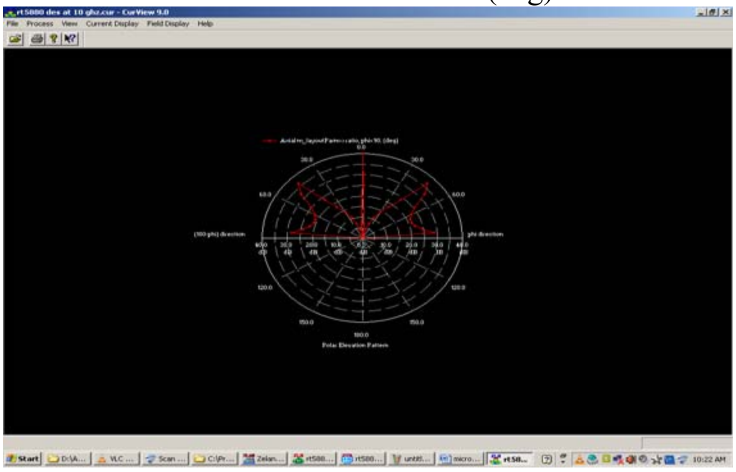
Axial Pattern at Phi =0(deg)



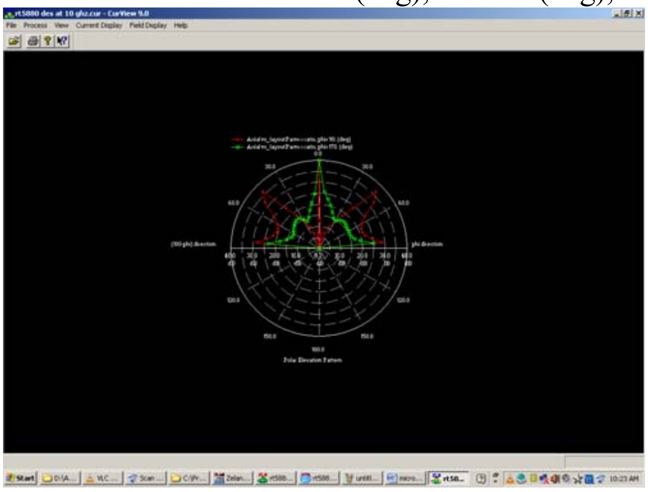
Axial Pattern at Phi =50(deg)



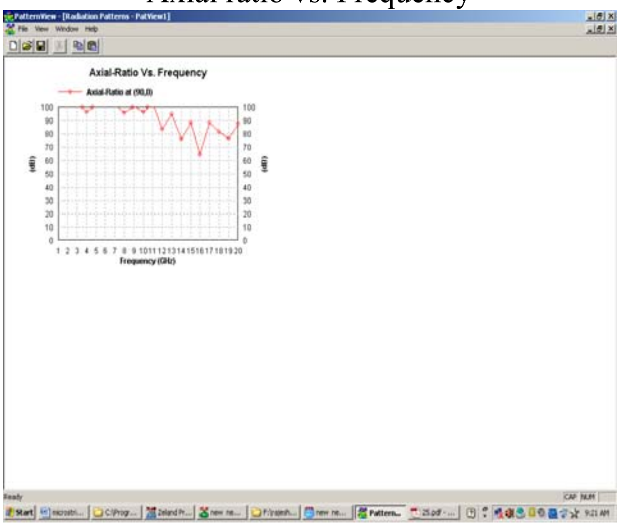
Axial Pattern at Phi =90(deg)



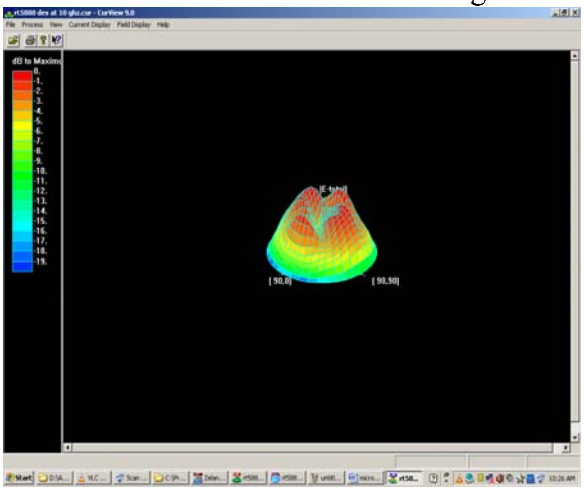

Axial Pattern at Phi =170(deg), Phi =90(deg),



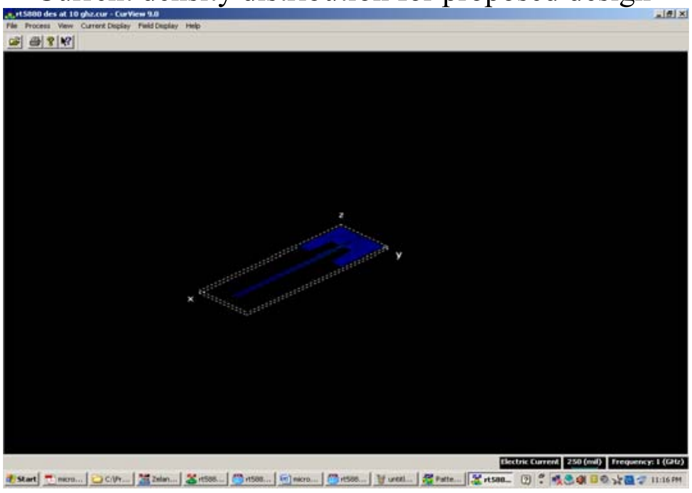

Axial ratio vs. Frequency



3D Elevation Pattern at 90 deg



Current density distribution for proposed design



Average current density

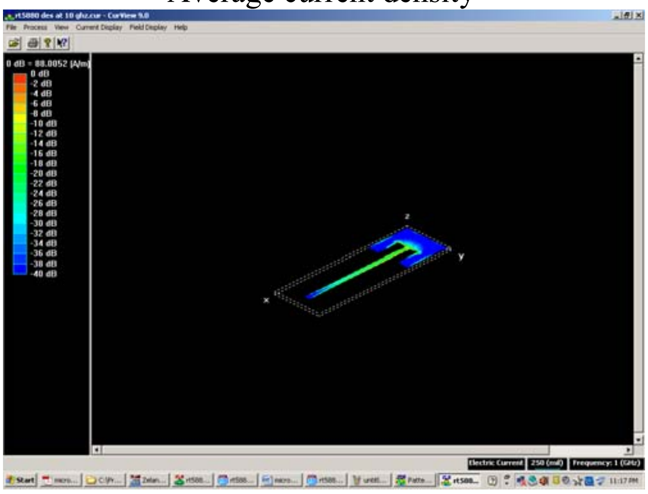


**Table 1:** dB [S (i j)] in dB and Ang[S (i j)] in Deg

| Freq[Ghz] | dB[S(1,1)] |
|---|---|
| 1 | $-2.912e^{-0.02}$ |
| 2 | $-5.98e^{-0.02}$ |
| 3 | $-6.412e^{-0.02}$ |
| 4 | -0.1106 |
| 5 | -0.1389 |
| 6 | -0.9716 |
| 7 | -4.983 |
| 8 | -0.3035 |
| 9 | -0.3481 |
| 10 | -1.037 |
| 11 | -0.4362 |
| 12 | -3.744 |
| 13 | -1.181 |
| 14 | -10.35 |
| 15 | -3.385 |
| 16 | -1.22 |
| 17 | -2.361 |
| 18 | -4.519 |
| 19 | -2.868 |
| 20 | -3.089 |

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

| Frequency[GHz] | VSWR |
|---|---|
| 1 | 596.5 |
| 2 | 290.5 |
| 3 | 270.9 |
| 4 | 157.1 |
| 5 | 125.1 |
| 6 | 17.9 |
| 7 | 3.581 |
| 8 | 57.24 |
| 9 | 49.91 |
| 10 | 16.77 |
| 11 | 39.83 |
| 12 | 4.712 |
| 13 | 14.73 |
| 14 | 1.872 |

| | |
|---|---|
| 15 | 5.197 |
| 16 | 14.26 |
| 17 | 7.404 |
| 18 | 3.931 |
| 19 | 6.111 |
| 20 | 5.683 |

## 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. The proposed frequency range 14GHz (Ku Band) and Analysis Radiation Characteristics of micro strip Antenna by IE3D Simulator. The transmission line model seems to be the most instructive in demonstrating the bandwidth effects of the changing the various parameters. 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 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 E-Shaped multiband microstrip antenna effective work on 7GHz, 12GHz, at 14GHz (Ku Band) the proposed antenna work very effectively for pervasive wireless communication.

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