MICROSTRIP SMART ANTENNA WITH DUAL BAND FREQUENCY AT 1.61538 GHZ & 2.5463 GHZ

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Abstract: A design a patch antenna at frequency at 1.61538 GHz, The patch will be used as a feed for a TV offset feed dish and NASA light weight rainfall radiometer (LRR) and military aircraft. Therefore, we require a patch that will have a wide beam width to provide optimum illustration of the dish. Micro strip patch antenna is working on dual band of frequencies 1.61538 Ghz and 2.5463 Ghz. Therefore, this antenna can work as a smart antenna (An antenna which works on multiple frequencies). They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication and conformity. By use of this combination it has been seen that there is a step up of return loss. These structures are simulated using IE3d Electromagnetic simulator of Zeland's software incorporation.

***Index Terms* -** Rectangular Microstrip patch antenna, Bandwidth, Dual band frequencies, return loss, Directivity, VSWR.

I.INTRODUCTION

"Microstrip antenna consist a very thin metallic strip, called patch placed above ground plane. The strip and ground plane are separated by dielectric sheet called substrate". The patch is generally made of conducting material such as copper or gold and can take any possible shape. Due to its planar configuration and ease of integration with Microstrip technology, the Microstrip patch antenna has been heavily studied and is often used as elements for an array. The rectangular and circular patches are the basic and most commonly used Microstrip antennas [8, 11-13]. It consists four parts:

a) A very thin flat metallic region called radiating patch
b) A dielectric substrate
c) A ground plane
d) A feed, which supplies the RF power to radiating patch [9, 10]

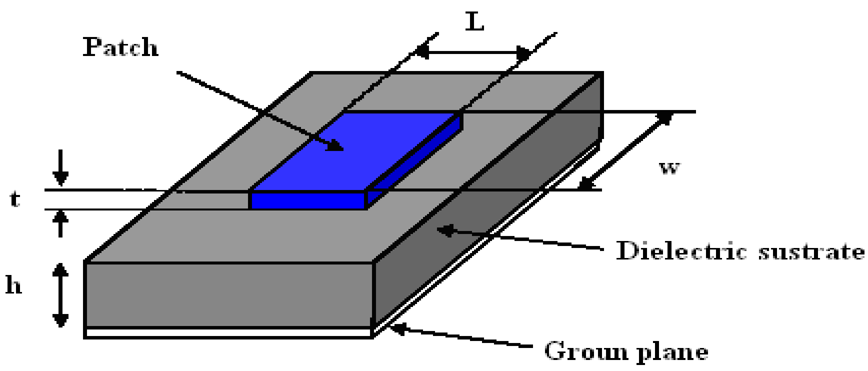


Fig.1 Micro Strip Patch elements

A design a patch antenna at frequency at 1.61538 GHz, The patch will be used as a feed for a TV offset feed dish and NASA light weight rainfall radiometer (LRR) and military aircraft. Therefore, we require a patch that will have a wide beamwidth to provide optimum illustration of the dish. To design the patch antenna first step is to perform some hand calculation to calculate the required parameters which involved in designing. After getting these required values, the simulated results obtained by using IE3D software.[1-3]

II.DESIGN SPECIFICATIONS AND FORMULAS

To design the patch antenna some parameters are necessary such as operating frequency, Dielectric constant of the dielectric material, substrate height etc. By using the formulas we can calculate the patch length, width, effective length, effective dielectric constant, resonant frequency etc. [4-5, 8, 12]

(a) Designing of Rectangular Micro Strip Patch Antenna

Given: Operating frequency (f_r) = 1.61538 GHz,

Dielectric constant of the substrate ε_r=4.4

Height of the substrate (h) =1.6mm

Loss tangent = 0.02

Feed type Transmission line

(b) Calculation of Width (W)

$$W = \frac{V_0}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Vo = free space velocity of light

ε_r = Dielectric constant of substrate.

(c) Calculation of Effective Dielectric Constant

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

(d) Calculation of Effective Length (L_{eff})

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}}$$

(e) Calculation of Length Extension (ΔL)

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

(f) Calculation of Actual Length

$$L_{eff} = L + 2\Delta L$$

(g) Calculation of Half Power Beam Width (HPBW)

The HPBW of Electric and magnetic field

$$\theta_E = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{7.03}{(3L^2 + h^2)\,k_0^2}} \qquad \theta_H = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{1}{2 + k_0 W}} \qquad K_0 = \frac{\pi}{\sqrt{\varepsilon_{reff}}\; L}$$

(h) Calculation of Directivity

$$D = (41253/\theta_E\theta_H)$$

(i) Calculation of Gain

$$G = (32400/\theta_E\theta_H)$$

III. SIMULATION RESULTS AND DISCUSSION

The software used to model and simulate the Microstrip patch antenna is Zeland's IE3D. IE3D is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, and other RF/wireless antennas. It can be used to calculate and plot the S11 parameters, VSWR, current distribution as well as the radiation patterns. [6-7]

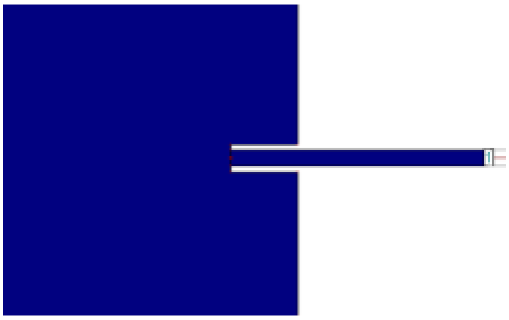


Fig.2: Rectangular Patch Antenna

Design Specification:

1) Width of the patch =44.45 mm
2) Length of the patch =57.05 mm
3) Dielectric material is Glass epoxy
4) Dielectric constant = 4.4
5) Substrate height = 1.6 mm
6) Loss tangent = 0.02
7) Width of Strip Line = 3.009 mm
8) Cut width = 5mm
9) Cut depth = 10mm
10) Path length = 32.815mm
11) Width of feed = 3.009mm
12) Feed type Transmission line
13) Length of the Strip Line = 38.525 mm
14) Operating frequency = 1.61538 GHz & 2.5463 GHz

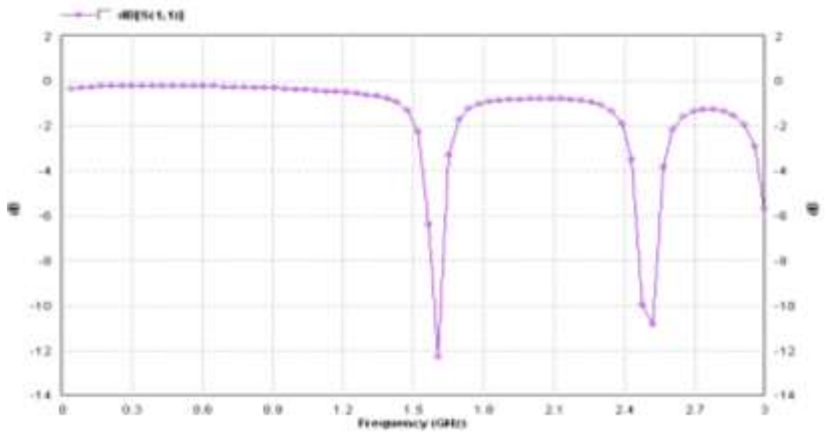


Fig.3: Return Loss v/s Frequency

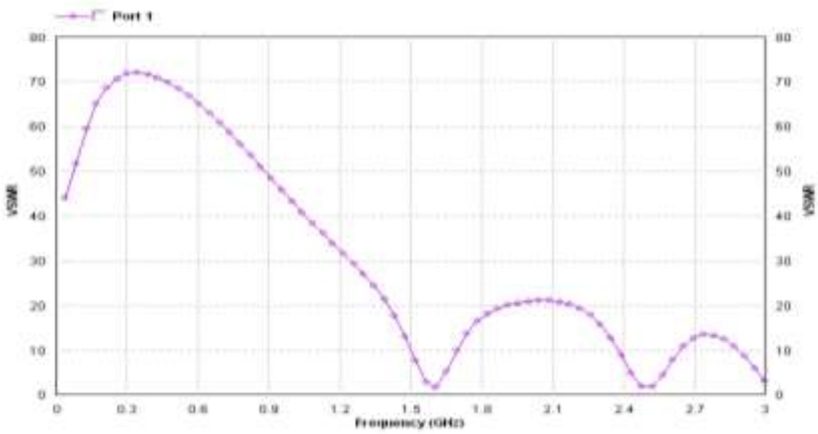


Fig.4: VSWR v/s Frequency

Frequency	1.61538(GHz)
Incident Power	0.01(W)
Input Power	0.00879643(W)
Radiated Power	0.00239638(W)
Average Radiated Power	0.000190698(W)
Radiation Efficiency	27.2426%
Antenna Efficiency	23.9638%
Gain	0.101676 dBi
Directivity	6.30612 dBi
3 dB Bandwidth	(80.1625,166.817)deg.

Table – 1: Radiation Properties of Simple Patch Antenna

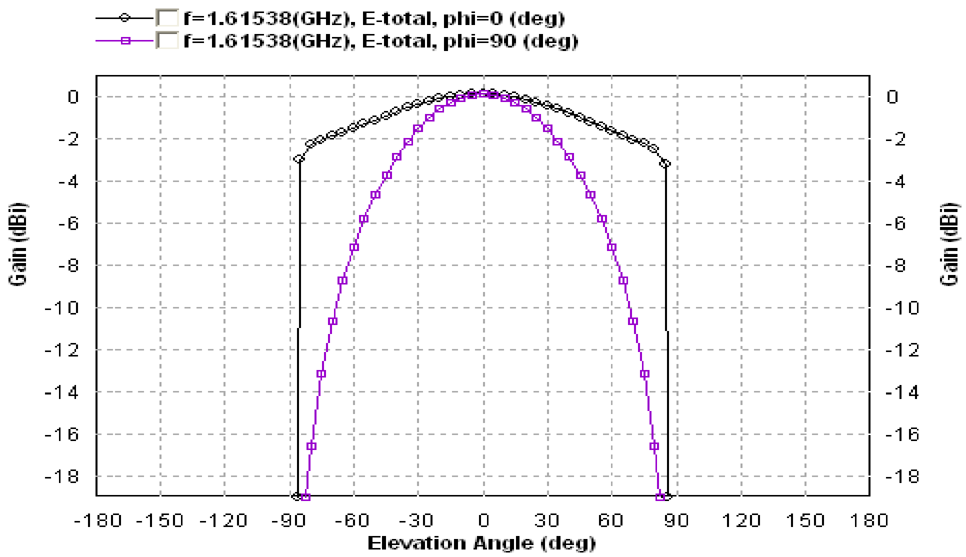
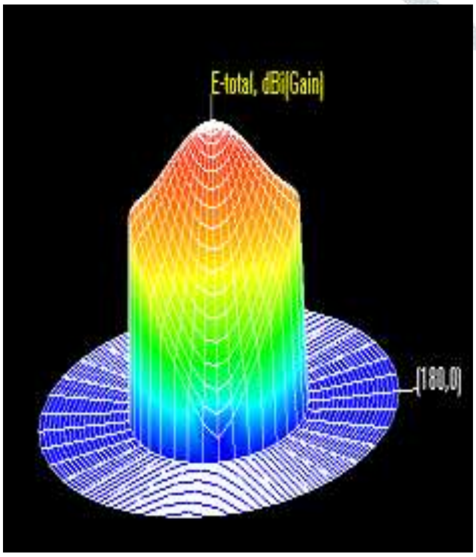


Fig. 5: Cartesian Elevation Pattern



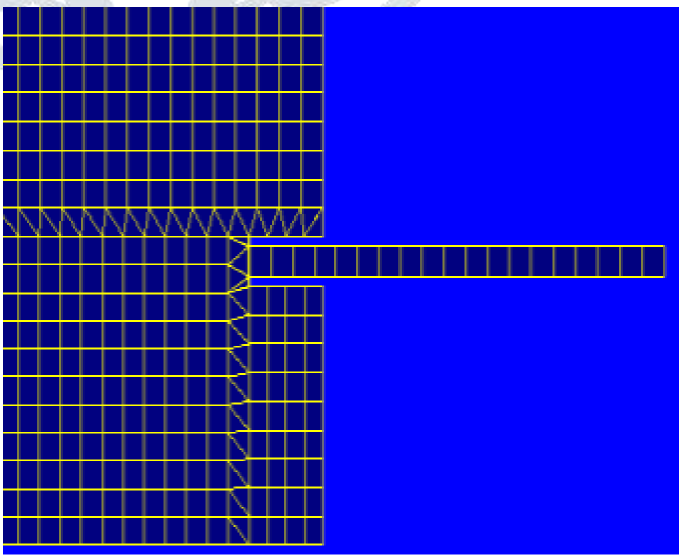


Fig.6: Mapped 3D pattern

Fig.7: 2D Grid Pattern

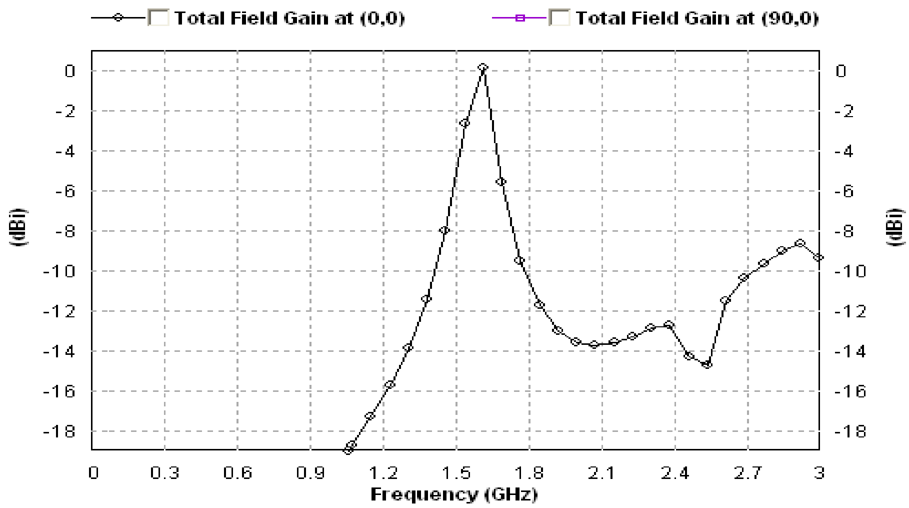


Fig. 8: Total Field Gain v/s Frequency

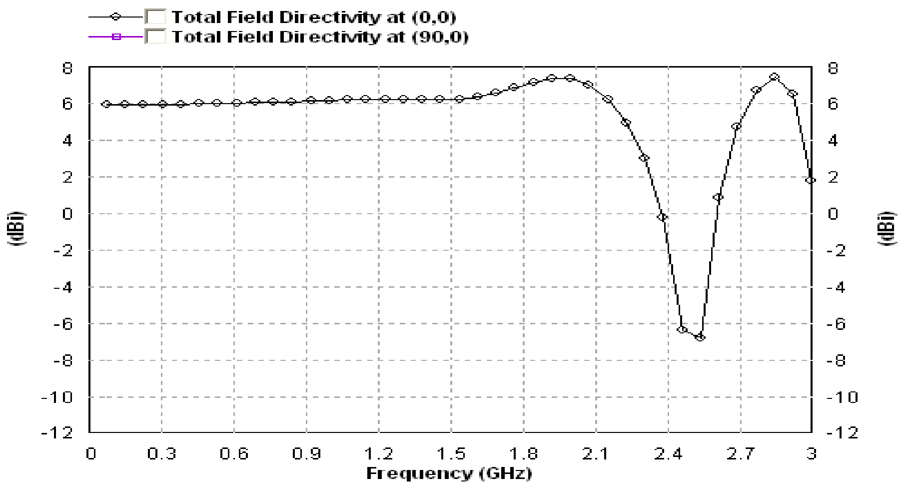


Fig.9: Total Field Directivity v/s Frequency

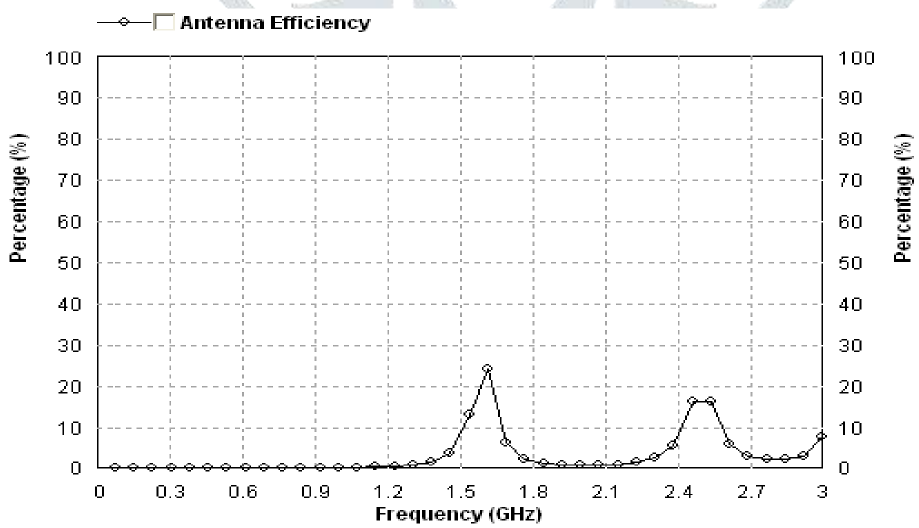


Fig.10: Efficiency V/s Frequency

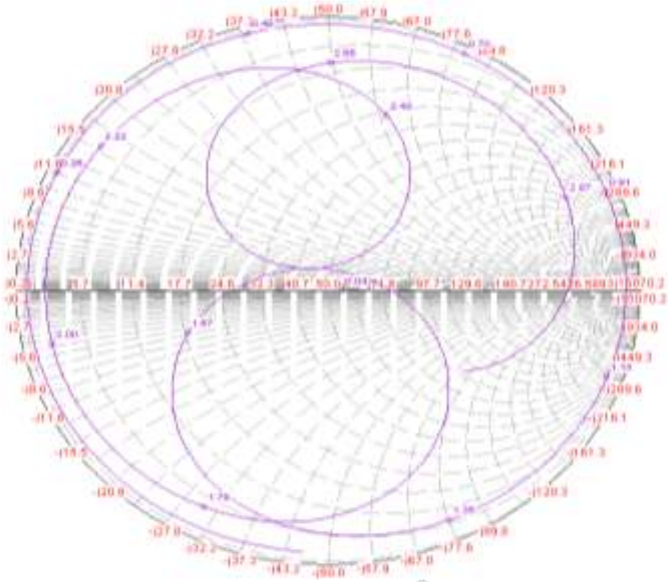


Fig11: Smith Chart

IV.CONCLUSION

A survey on microstrip patch antenna is presented in this report. Some effect of disadvantages can be minimized. Lower gain and low power handling capacity can be overcome through an array configuration. Some factors are involved in the selection of feeding technique. Particular microstrip patch antenna can be designed for each application and different merits are compared with conventional microwave antenna.

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