Multiband Array Antenna towards Microstrip Patch antenna using Resonant Frequency for s band Application

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Abstract— In today's world, requirement for lower-weight, low-cost, low-profile, and effective-use transmitters is growing by the day. For addressing these parameters in a variety of applications, microstrip patch antennas are more popular than other antennas. The main issue with these types of microstirp patch antennas is that they have a high return loss, VSWR, and bandwidth, but these issues can be rectified utilising a design technique. The method of design was to use mirror image layouts, which was a simple and easy way to improve performance. The efficiency of a simple patch cannot be influenced by any single structure that lacks a mirror reflection. In this study, the two +-shaped constructions are used, and the results are in good agreement. In today's world, these antennas have a variety of uses, including WLAN and s band applications. In future, various frameworks will be used to improve the results that have been produced thus far.

Keywords— **Bandwidth, Rectangular Microstrip patch Antenna(RMPA), Return Loss, Ground Plane, FR4 ,Resonant frequency.**

1.Introduction In recent years, advancements in communications networks have necessitated the creation of low-cost, light-weight, low-profile antennas capable of delivering great performance across a broad frequency band. The goal of prospective personal communication device development will be to allow image, voice, and data communications at any moment and from everywhere on the planet. To adequately cover the available operating bands, new communication endpoint transmitters must meet criteria of multi-band or wideband activities. The manufactured transmitter performance was measured and matched to modeling findings. In addition, we've discussed how to use FR4 for a variety of objectives, including antenna area diminution and other mode alteration-related tasks. The efficiency of rectangular patch transmitter built on FR4 substrate has been compared to that of similar antenna built on a standard FR4 substrate. Microstrip patch antennas are extensively employed in wireless devices in modern wireless communication networks. As a result, transmitter shrinking has become a critical challenge in lowering the overall size of the communication system. Microstrip patch antennas are extensively employed in wireless devices in contemporary wireless communication networks. The suggested Antenna's advantages, such as light weight, lower profile, lower cost, easy integration with innovation and engineering, and considerably simple production, are driving demand in commercial and military wireless systems. All of these antennas may be manufactured with the help of IE3D simulation software and have extremely crisp features. Because of its lower profile and tiny size, suggested RMPA can be employed in a wide range of wireless communication technologies. Due to its lower profile and smaller weight, microstrip antennas are widely utilized in radio communication technologies A Microstrip, Patch transmitter in its most basic form, contains a transmitting patch on one end of dielectric substrate with a grounding plane on other. The patch is typically made of conductive metals like gold or copper and may be manufactured into any shape. The transmitting patch and feed lines is normally photo etched on

dielectric substrate. The impedance bandwidth and buy back loss are critical factors of any form of antenna. The impedance bandwidth is determined by the specifications of the patch transmitter component and the feed utilized. The bandwidth is usually restricted to fewer percent of the total. This is one of the drawbacks of a standard patch transmitter. The bandwidth and transmission loss of a FR4-based rectangular microstrip patch transmitter are significantly improved. The FR4-based rectangular microstrip patch antenna was designed using IE3D, a software tool for electromagnetic analysis and design.

2. THE SUGGESTED ANTENNA STRUCTURE'S DESIGN METHODOLOGY AND SIMULATION

A design approach is detailed based on the reduced formulation that leads to the realistic development of square microstrip patch antennas. The process assumes that given information comprises the substrate's dielectric constant (r), resonant frequency (fr), substrate height (h), and loss tangent. (δ). SPECIFY :- Er =4.4

h=1.6mm

 fc=2 GHz**2.**

δ=0.02

Zeland Inc's IE3D was used to design and test the Microstrip patch transmitter. The electromagnetic simulation IE3D is built on the method of moments and is a full electromagnetic simulation. It examines 3D and multilayer general form structures. Patch, transmitters wire antennas, and other RF/wireless antennas have all been designed with it. It may be utilized to determine the return loss, VSWR, and bandwidth.

The following are the critical criteria for designing rectangular microstrip Patch Antenna:

- Length(L): Two sides were chosen to be 45.64mm in length each.
- Width(W): Two sides were chosen to be 35.14mm in length each.
- Frequency of operation(fo): The transmitters' frequency response should be chosen carefully. For our design, we chose a resonance frequency of 2.0GHz.
- Dielectric constant of substrate(ε_r): The dielectric constant of the material we chose for theor design is 4.40. Because it lowers the antenna's dimensions, a substrate with just a large dielectric constant was chosen.
- Height of dielectric material (h): It is critical that the microstrip patch antennas used in cellular phones are not too bulky. As a result, the dielectric substrate has a height of 1.6mm.
- Length (L) and Cutting Width (w): 5.0mm and 10.0mm were chosen as the length and width, respectively

Hence, the design's most important aspects are:

L	=	45.64mm
W	=	35.14mm
Cutting Width	=	5.0mm
Cutting Length	=	10.0mm
fo	=	2.0GHz
ε_r	=	4.40
h	=	1.60mm
Tangent loss	=	0.02

2.1 Designing Microstrip Patch Antenna

Step # 01: Computation of the Width (*W*)

The Microstrip patch antenna's width is specified as:

$$\frac{1}{2Fr\sqrt{(\mu\varepsilon)}}\sqrt{\left(\frac{2}{(\varepsilon r+1)}\right)} = \frac{C}{2Fr}\sqrt{\left(\frac{2}{(\varepsilon r+1)}\right)} \qquad (1)$$

Replacing c = 3.00e+008 m/sec., ε_r = 4.40 and fo = 2.0GHz

Step # 02: Computation of Effective dielectric constant (εreff):

The effectual dielectric constant is:

$$\varepsilon ff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \qquad (2)$$

Step # 03: Computation of the Effective length (*Leff*)

The effectual length is:

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}} \qquad (3)$$

Replacing Eeff = 4.40, c = 3.00e+008 m/sec and fo = 2.0GHz

Step # 04: Computation of the length extension (Δ*L*):

$$\Delta L = 0.412h\frac{\left(\varepsilon_{ref}f+0.3\right)\left(\frac{W}{h}+0.264\right)}{\left(\varepsilon_{reff}-0.258\right)\left(\frac{W}{h}+0.8\right)} \qquad (4)$$

Step # 05: Computation of actual length of patch(*L*):

The genuine length is produced by: L = Leff- 2ΔL   (5)

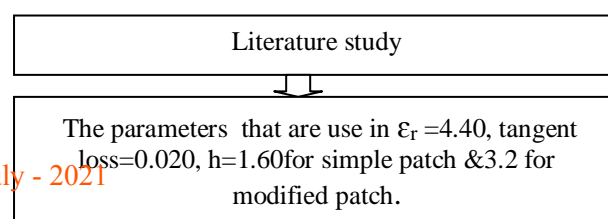**Step # 06: Computation Of VSWR**

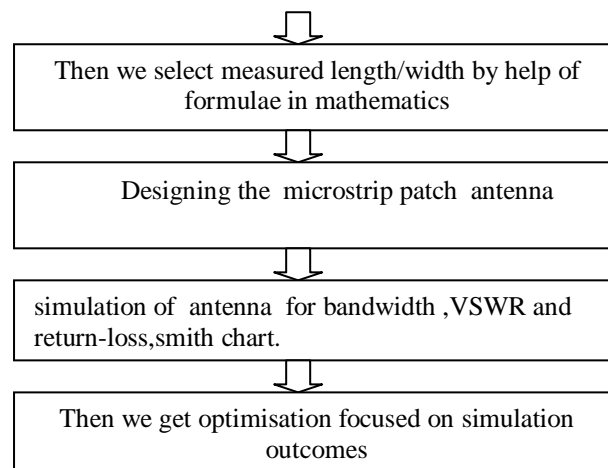$$VSWR = \left(\frac{1+|\Gamma|}{1-|\Gamma|}\right) \qquad (6)$$

Step # 07: Computation of Return Loss

When such an electromagnetic wave reaches a mismatched load or indeed a line interruption while travelling down a transmission system, some of incidence power is redirected back down line. The return loss is calculated as follows:

$$RL = 10\log_{10}\left(\Gamma\right)dB \qquad (7)$$

2.2   Methodology BASED DISIGN

Literature study

The parameters that are use in ε_r =4.40, tangent loss=0.020, h=1.60for simple patch &3.2 for modified patch.

Then we select measured length/width by help of formulae in mathematics

Designing the microstrip patch antenna

simulation of antenna for bandwidth ,VSWR and return-loss,smith chart.

Then we get optimisation focused on simulation outcomes

3.Designingof Rectangular microstrip patch antenna Configuration

Figure 1 depicts the planned antenna design. The suggested L&W size is printed on substrate with a height of h=1.60 and a comparative permeability of 4.4. On a ground board, the print is scratched. A 50-microstrip line feeds the slot. Figure 1 shows the basic square microstrip line fed printed transmitter design The dimension of is calculated by for stimulating the working frequency at roughly 2 GHz. Figure 1 shows a Basic Rectangular Microstrip Patch Transmitter Feed by Microstrip Line, wherein c is frequency of light in atmosphere, is effectual relative permeability and L is length. The resonance wavelength of a microstrip patch transmitter is 2 GHz. The patch is 35.44mm in length and 45.65mm in width. The microstrip thread which is utilised for feeding is 32.82mm in length. We used a double-sided copper PCB to create this transmitter. The metal field on lower side of the PCB serves as satellite's ground, and we designed the patch of providing proportions on the upper side of the PCB. To use a dielectric substrate with a altitude of 1.60mm and dielectric constant of 4.40mm, the entire geometry is simulated and raised effectively. The material's loss tangent is 0.02. The feed to the antenna is provided via microstrip feed line.

4. Design of simple rectangular microstrip patch antenna
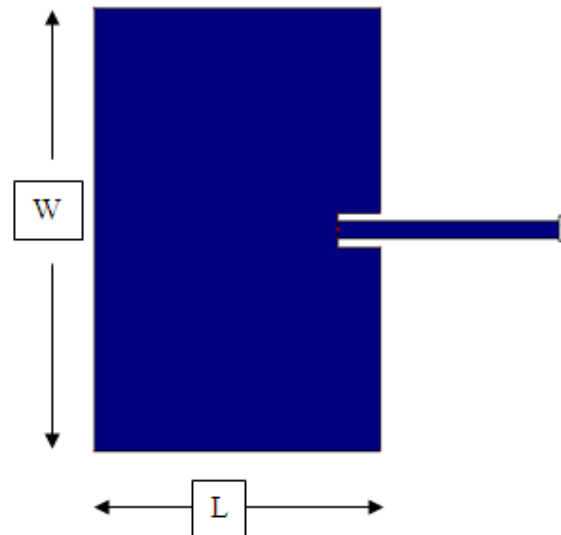
Figure 1(a) Simulated geometry of Simple Patch Antenna

Length of patch antenna = 35.44136mm

Width of patch antenna = 45.64356mm

Resonant frequency = 2.0GHz

Summary of Design Parameters of Simple Patch Antenna

Frequency	2GHz
Length	35.44mm
Width	45.64mm
Cutwidth	5.0mm
Cutdepth	10.0mm
Pathlength	32.82mm
Pathwidth	3.009mm
Return loss	-26.16dB
VSWR	1.132

4.4.1 S Parameter Display and Bandwidth Calculation

The simulation is done by varying feeding positions and s-parameter is studied for each simulation and tabulated by taking each case. Thus the enhanced bandwidth of T-shape rectangular microstrip patch is obtained at probe feed position (1,0).
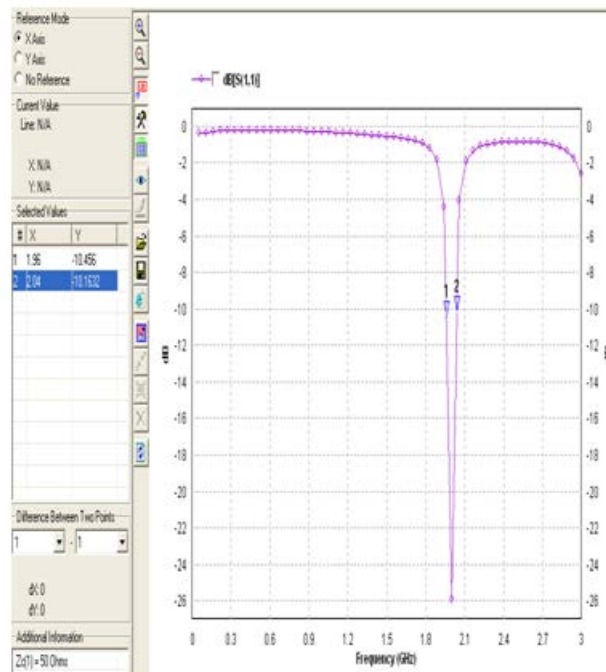
Figure 1(b): S parameter Display

At feed point:(1,0)
F1=1.96 GHz
F2=2.04 GHz
Bandwidth=(f2-f1) *100/ Fc

Bandwidth= 9%

### 4.4.2 Bandwidth Computation:

The bandwidth calculation at feed position (1,1), maximum bandwidth is achieved. From the figure 3.3, frequency f_1 is taken as 1.96 GHz and frequency f2 is taken as 2 GHz . Therefore   the bandwidth is obtained after doing calculation as shown in figure 3

4.4.3 Return Loss:

The return loss at feed position (1,1), we got retrun loss from figure 1(b),the return loss is obtained -26db.

4.4.4 VSWR:

We got VSWR form figure 1(c) ,the VSWR is obtained >1.
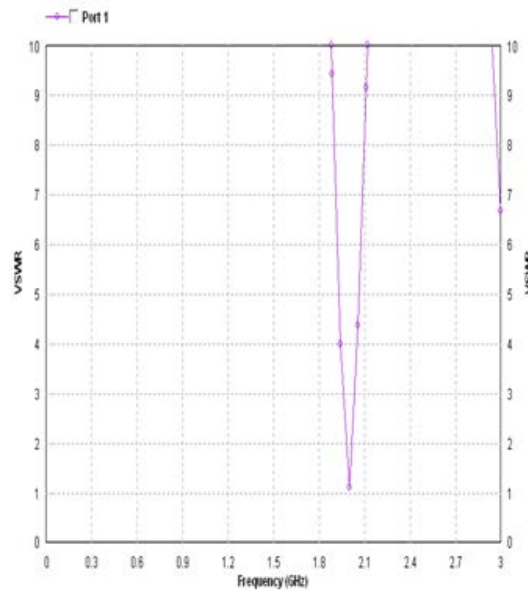
1.(c) VSWR (Voltage Standing Wave Ratio)

3.1.Geometry & Designing

A tiny compact T shaped microstrip patched transmitter is represented in this paper. To improve the efficiency of this T-shape microstrip patch antenna, reflection designs were used. The performance of a simple patch cannot be influenced by any single structure that lacks a mirror reflection. In this study, the two T-shaped structures are employed, and the results are in strong agreement. The T shape might result in good impedance matching. The proposed microstrip patch satellite's shape is shown in Fig.2. The patch transmitter is developed on a FR4 substrate with a width of 3.20mm and a relative dielectric constant (r) of 4.40, as depicted in Fig.2. It has a small size of 45.64mm × 35.14mm (W x L).

A microstrip line with a cut width of 5.0mm and a cut depth of 10.0mm feeds the radiator. A 50 microstrip line with a ferquancy of 2GHz is printed on the partially grounded substrate as the excitation.

The modified 1st ground plane controls the impedance bandwidth of a rectangular patch by acting as an impedance matching element. ws stands for antenna width, and ls stands for antenna length.

The suggested antenna may be configured to function at 2.0GHz frequency by selecting these parameters. The findings of both simulations and experiments are also discussed. This project's simulation results come from Zeland's IE3D simulation.

1. Design parameters of Modified 1 Microstrip Patch Antenna

Co-ordinates 1st:

The slot size of
ws1, ws2, ws3, ws4, ws5, ws6, ws7, w8, ws9, ws10, ws11, ls1, ls2, ls3, ls4, ls5, ls6, ls7, ls8, ls9, ls10, ls11 are 10, 10, -10, -10, -5, -5, -2.5, -2.5, 2.5, 2.5, 5, 5, 10, 7.8, 22.8, 22.8, 7.8, 7.8, 17.8, 17.8, 7.8, 7.8, 17.8, 17, 8, 7.8 and 7.8mm respectively.

Co-ordinates 2nd
The slot size of
ws1, ws2, ws3, ws4, ws5, ws6, ws7, w8, ws9, ws10, ws11, ls1, ls2, ls3, ls4, ls5, ls6, ls7, ls8, ls9, ls10, ls11 are 10, 10, -10, -10, -5, -5, -2.5, -2.5, 2.5, 2.5, 5, 5, 10, -7.8, -22.8, -22.8, -7.8, -7.8, -17.8, -17.8, -7.8, -7.8, -17.8, -17, 8, -7.8 and -7.8mm respectively.

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Co-ordinates 3rd:
Dig rectangular hole at X=0 ; y=0
L=5mm,w=2.5

Co-ordinates 4th :
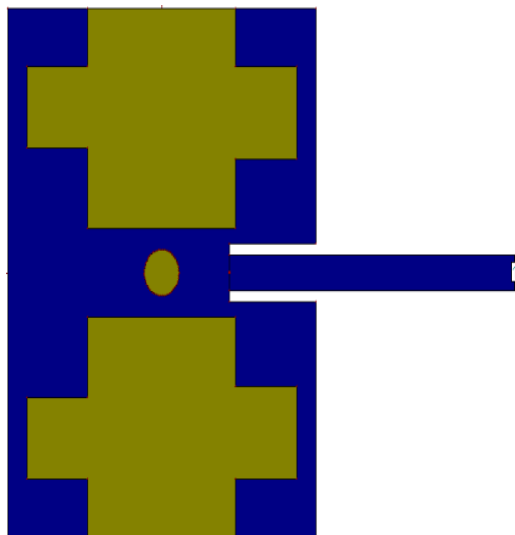Draw a rectangular at X=0,Y=0
(Rotation angle 45) l=5mm,w=5mm

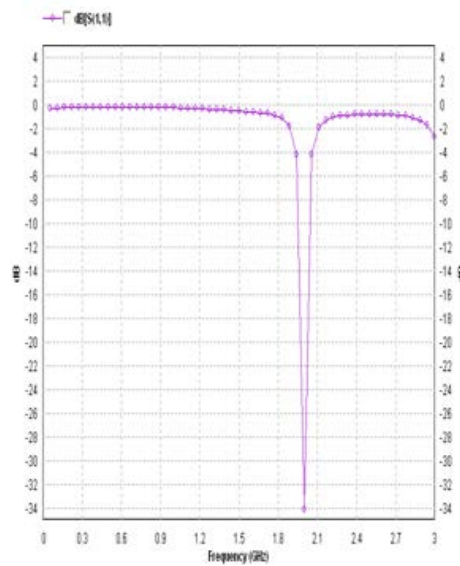figure 2(a): **Rectangular Microstrip Patch Antenna**

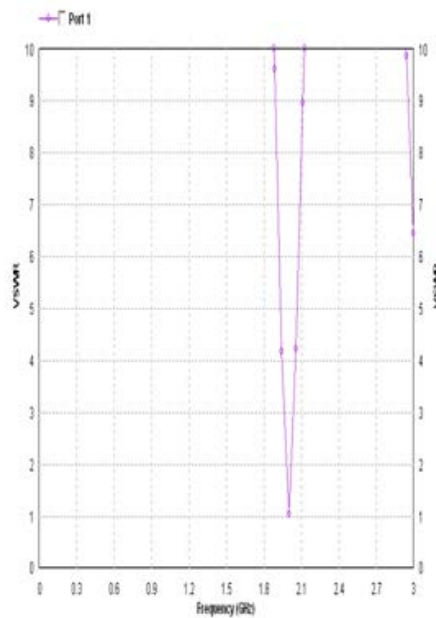**Figure2(b): Simulation Results of Return Loss of Rectangular Microstrip Patch Antenna**

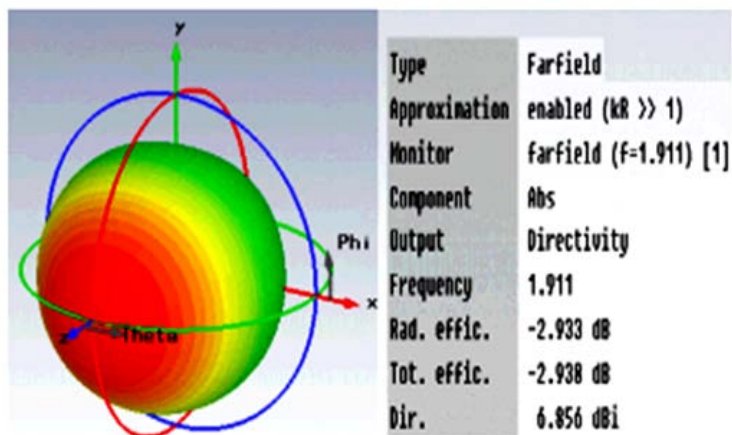**Figure 2(C): VSWR for microstrip Patch Antenna**

Fig2(d)Radiation Pattern of modified 1 rectangular microstrip patch antenna
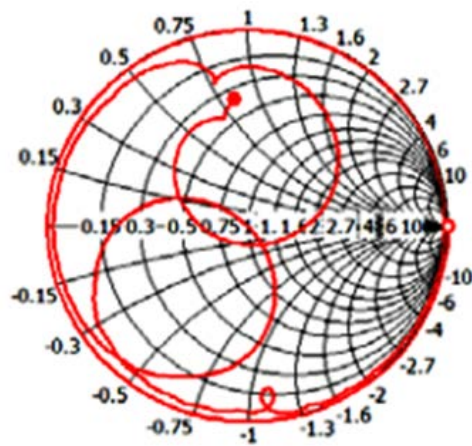

Fig2 (e) Smith chart for modified microstrip patch antenna 1

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4. Conclusion

This Paper describes the result of proposed design of different modified Rectangular microstrip patch antenna using FR4 were computed mathematically replicated on IE3D software. In this article, it is discovered that using FR4 Structure on a Rectangular Microstrip Patch Antenna at 1.60mm or 3.20mm Layer reduces Return Loss, VSWR, and increases Bandwidth.

The simulated result of modified rectangular microstrip patch antenna with FR4 structure are depicted Figure2(a) and 2(b)At 2.0GHz frequency simulated, whenever it is designed with FR4 structure at 3.20mm it depicts return loss is -33dB and VSWR is 1.040, which depicts a considerable diminution of return loss and VSWR using FR4 structure.

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