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Design of Patch Antenna for Wideband Communication

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Abstract: ***Microstrip Patch Antenna are presented in this paper, the total bandwidth of the antenna is 1.9GHz to 3.10GHz which obtained a Dual-band frequency from 1.9GHz to 2.3GHz and 2.9GHz to 3.4GHz is used for Wideband applications at resonant frequency obtained Return loss -16dB at 2GHz and -28dB at 3.1GHz. The main dimensions are used in this Antenna are length (L), Width (W), Height from the ground plane and Dielectric Substrate. The Proposed Antenna was simulated in IE3D (Electromagnetic) simulation software tool.***

Keywords: Microstrip line feed, IE3D software tool, VSWR, Return loss

1. Introduction

There are several Antennas used for Wireless Communications, radars ect.,but Microstrip Patch Antenna is a very Compatible and light weight which is easy to operate and flexible. Microstrip Patch Antenna consists of ground plane, dielectric substrate and a conducting material made of copper or gold. Antenna is made through many possible shapes such as square, circular, rectangular,etc [1].Here in this paper choose an Rectangular Patch Antenna shown in fig.1. In[2] U-shaped patch Antenna was designed using probe feeding techniques by putting slots in rectangular Patches of antenna to enhance bandwidth and impedance for WiMAX applications, By combining more than two antenna to form an array (stacked antenna) which make antenna broader, achieves stronger signals and provide portable broadband connectivity for WiMAX applications. In [3] Antenna was constructed for high efficiency circularly polarized broadband using Aperture coupled feeding techniques for RF applications. L shaped feed line was used to construct antenna. The proposed antenna was used to improved high efficiency. In [4] Multiband Microstrip antenna was designed using Composite right/left handed Transmission line (CRLH-TL) array structure for several multiband applications. The proposed antenna was used for the analysis of S-parameter. In [5] M-shaped compact patch Antenna was constructed using coaxial feed technique which has rectangular and circular slots and used to improve impedance, bandwidth, polarization and Gain for RF radars applications.

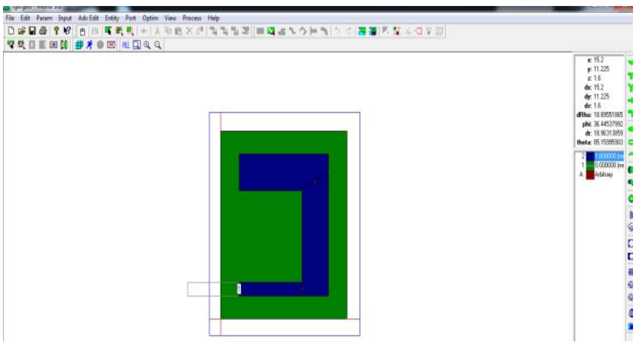


Figure 1: Microstrip patch antenna designed using IE3D

2. Design Procedure of Rectangular Patch Antenna

Step 1: Calculation of the Width (W):
The width of the Microstrip patch antenna is given as:

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}}$$

Substituting c = 3x10^8 m/s, εr= 4.2 and fo= 3.0 GHz, we get:
W = 0.031 m = 31 mm

Step 2: Calculation of Effective dielectric constant (*εreff*):
The effective dielectric constant is:

$$\in_{reff} = \frac{\in_g + 1}{2} + \frac{\in_g - 1}{2}\left[1 + 12\frac{h_e}{W}\right]^{-\frac{1}{2}}$$

Substituting εr = 4.2, W = 31 mm and h = 1.65mm we get:
εreff = 3.84

Step 3: Calculation of the Effective length (*Leff*):
The effective length is:

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

Substituting εreff = 3.84, c = 3x10 ^{8} m/s and fo =3.0 GHz we get:

Leff = **0.2451 m = 24.51 mm**

Step 4: Calculation of the length extension (Δ*L*):
The length extension is:

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

Substituting εreff = 3.84, W = 31 mm and h = 1.65 mm we get:

ΔL = 0.5088 mm

Step 5: Calculation of actual length of patch (L):

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

The actual length is obtained by:

Substituting Leff = 40.625 mm and ΔL = 0.51 mm we get:
L = 0.2344m

Step 6: Calculation of the ground plane dimensions (*Lg* and *Wg*):
The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by [9] that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for thisdesign, the ground plane dimensions would be given as:

$L_g = 6h + L = 6(1.65) + 24 = 34$ mm

$W_g = 6h + W = 6(1.65) + 31 = 41$ mm

3. Implementation and Results

S Parameter Return Loss (Db) Vs Frequency
The total bandwidth of the antenna is 1.9GHz to 3.10GHz which obtained a Dual-band frequency from 1.9GHz to 2.3GHz and 2.9GHz to 3.4GHz is used for Wideband applications at resonant frequency obtained Return loss -16dB at 2GHz and -28dB at 3.1GHz. Hence we achieve good bandwidth at 3.1GHz frequency

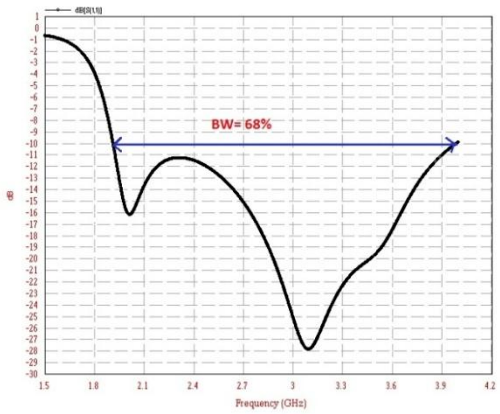


Figure 2: S-parameter plot for Return loss v/s frequency

Smith Chart:
Smith Chart is a Graphical aid of RF Electromagnetic which is used to solve problem with Transmission lines. Smith chart is used to solve problem of any charactertics impedance. In smith chart used impedance normally 50ohms. As such, figure.4. shows that the input impedance of the port was matched with the normalized Z_C value of 50 Ω at the frequency 2.708 GHz, which is near the operating frequency of 4.0

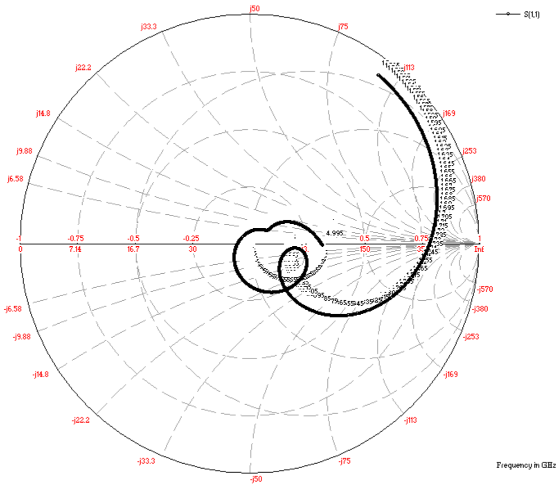
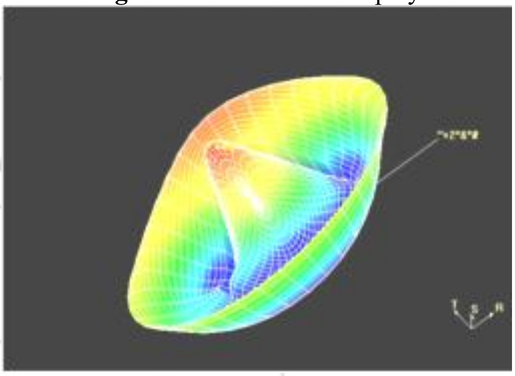


Figure 3: Smith Chart Display



3D Pattern
Figure 4: 3-D pattern of patch Antenna

The 3D current distribution plot gives the relationship between the co-polarization (desired) and cross-polarization (undesired) components. Moreover it gives a clear picture as to the nature of polarization of the fields propagating through the patch antenna. clearly shows that the Patch Antenna .

VSWR VS FREQUEQNCY PLOT:

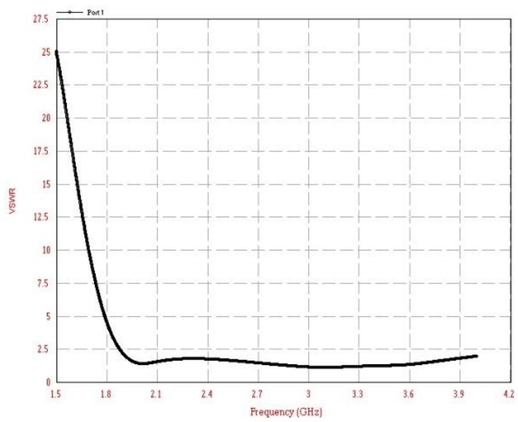


Figure 5: VSWR Vs frequency graph

4. Conclusions

The optimization of the Microstrip Patch is partially realized which concludes that the IE3D code was functioning correctly. The future scope of work revolves around increasing the efficiency and decreasing the run time of the IE3D code by using a distributive computing platform. Realization of results by the modified PSO would be concluded with the fabrication of the patch of the Microstrip Patch Antenna. The investigation has been limited mostly to theoretical study due to lack of distributive computing platform. Detailed experimental studies can be taken up at a later stage to find out a design procedure for balanced amplifying antennas.

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Pratiksha Singh Gaur passed B.Tech degree in Electronics and Communication engineering form college of science, and engineering Jhansi, U.P, Uttar Pradesh technical university luck now. She has published 4 papers in International Journal and publishes 3 papers in national seminar. She has completed M.Tech from Amity University, Gwalior.

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