Design of a Compact Micro strip Patch Antenna for Ku-Band Applications

Siva Rama Krishna Badiga[1], Anirudh Boddapati[2] , Sk. Masthan Vali[3]
(Department of ECE, PVP Siddhartha Institute of Technology, Kanuru, Vja

Abstract

The planar nature of micro strip antenna has brought a rapid growth in the development of airborne antennas. Such antennas are used in radar, military and satellite communications. our prime focus is to design a micro strip patch antenna at center frequency 14.9GHz in ku-band with 1GHz band width and dielectric constant of substrate RT duroid 8880 approximately 2.2 and loss tangent factor 0.0009 [6]. The other significant parameters like VSWR, Gain and Return loss are in the acceptable agreements. The same is simulated in CST and the results so obtained are formulated [3].

Key Words: Micro strip patch, CST-Ms, Center frequency, Fringe fields, Effective dielectric constant

1. Introduction:

In the recent years tremendous change in wireless communication requires the design of a sophisticated antenna with special characteristics. Antennas like slot, horn, micro strip, microwave, and wired etc [6] have their own properties and advantages. While coming to the micro strip patch antenna, it has its own advantages such as low cost, light weight, low volume, because of their planar nature. it can compatible with integrated circuits and linear and circular polarization is achieved by changing the feeding technique. However some limitations are associated with micro strip patch antenna such as limited bandwidth and low radiation efficiency [4].

The analysis of micro strip antenna can be done in several ways. they are Transmission Line model, Cavity model and integral and differential equation Model. Although the micro strip antenna looks resembling a simple structure but the analysis is quite complicated [1]. In the above Transmission Line model is easier but it less accurate rather than others.

The micro strip antenna has two conductors like co-axial cable as shown in the figure (a). Upper conductor acts as a radiating patch and the lower conductor acts as a ground plane. The conductor usually made up of gold (or) copper. The radiating patch can be virtually of any shape i.e. rectangular, circular, pyramid etc. but in analysis point rectangular is more preferred than the others. The substrate dielectric constant should be less than $\varepsilon_r \leq 10$ in order to enhance the fringe fields that account for radiation.

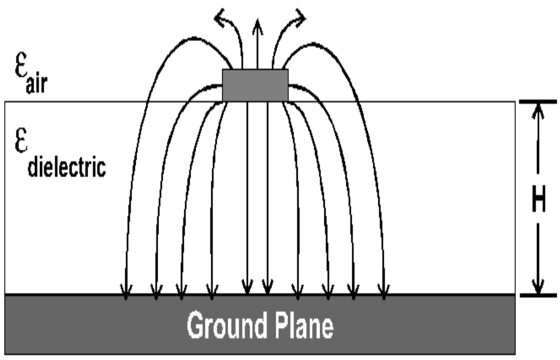

Fig (a): E-fields in MPA

2. Design of Microstrip Patch

Design of micro strip patch antenna needs several aspects to be considered in order to get desired results. They are relative dielectric constant (ε_r) and loss tangent factor (δ). High relative dielectric constant may compact the patch, but it reduces the band width, likewise the high loss tangent factor reduces the antenna efficiency and it may increase the feed loss also. In order to compensate this we increase the thickness of the substrate. Assume patch width W=7.2mm is calculated using the equation [6].

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

Where c = velocity of light in free space

The practical length of the δ is given by the following equation

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

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Where,

$$\Delta L/h = \left[0.412 \times \frac{(\varepsilon_{eff}+0.3)\times(w/h+0.264)}{(\varepsilon_{eff}-0.258)\times(w/h+0.8)}\right]$$

$$\varepsilon_{reff} = \left[\left(\frac{\varepsilon_r+1}{2}\right) + \frac{\varepsilon_r-1}{\left(2\times\sqrt{(1+12\times h/w)}\right)}\right]$$

And $$L_{eff} = \left[\frac{c}{2\times f_r \times \sqrt{\varepsilon_{eff}}}\right]$$

Where L_{eff} the effective length of the patch is, $\Delta L/h$ is the normalized extension of the patch length and ε_{reff} is the effective dielectric constant.

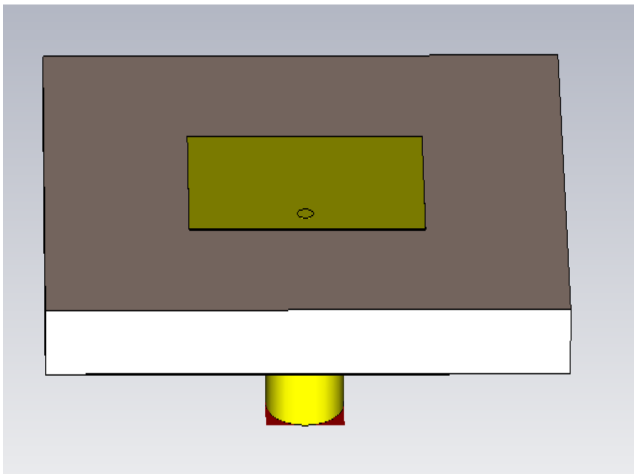

Fig (b): Proposed Antenna Configuration

The designed antenna as shown above in fig (b), the patch having a Length=5.4mm, Width=7.2mm and the thickness of the substrate is 1.5mm with a dielectric constant of 2.2. A simple probe-fed technique is used to energize the patch with a microwave source. The return loss of the designed antenna is less than -15 db throughout the bandwidth. VSWR shows how well the designed antenna is matched with cable, for a perfect matching VSWR is would be 1:1, in our design we achieved a VSWR is 1.023 as shown in fig (d).

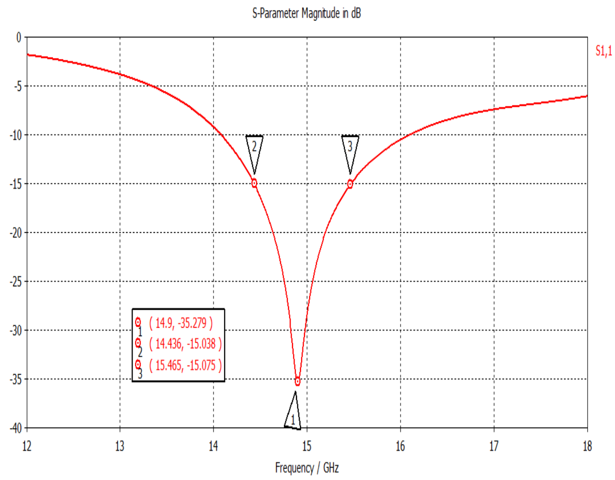

Fig (c): Return Loss Vs Frequency

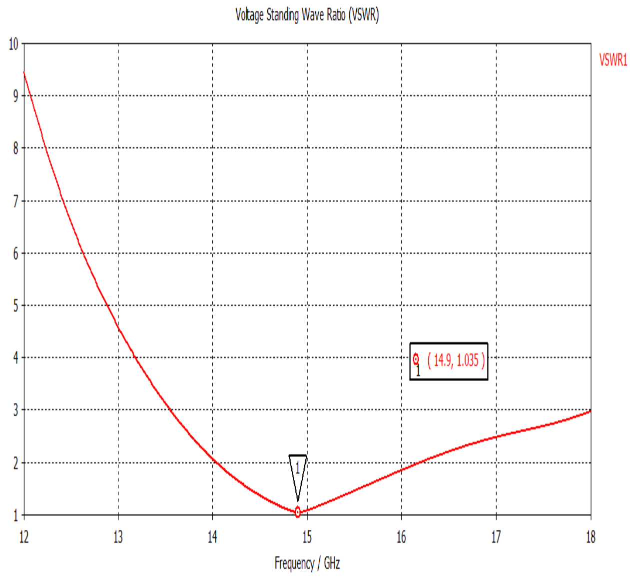

Fig (d): VSWR Vs Frequency

3. Simulation results:

The designed antenna is simulated in CST and the obtained results are shown below

- Simulated antenna is resonating at 14.9 GHz with 1GHz bandwidth
- The return loss is less than -35 db is achieved as shown in the fig (c)
- VSWR of designed antenna is 1.023 at centre frequency as shown in the above fig(d)
- The designed antenna has a directivity of 6.24 db

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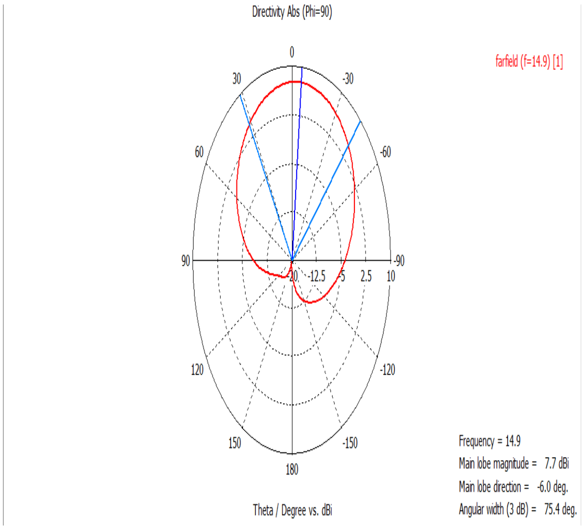

Fig (e): Total Directivity of antenna at f=14.9GHz

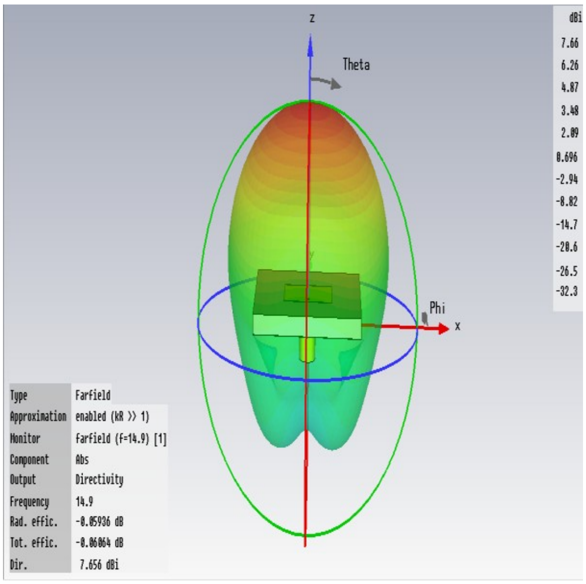

Fig (f): 3-D Radiation Pattern of antenna at f=14.9GHz

4. Conclusion:

In this paper, we had presented a rectangular Micro strip patch antenna and it is carried out by CST software. The designed antenna is operated at 14.9GHz with 1GHz band width which comes in Ku-band, low Return loss, Low VSWR and High directivity makes this antenna highly applicable in wireless communication systems.

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[1]**Siva Rama Krishna Badiga** was born in Gudivada, on Aug. 25, 1986. He received his B.Tech. degree in Electronics and Communication Engineering from CMR Engineering College Hyderabad in 2010, and the M.Tech. degree in Microwave and Communication Engineering from PVP Siddhartha Institute of Technology in 2013. His research interests include Micro strip, Microwave and Optical Communication.

[2]**Anirudh Boddapati** was born in Vijayawada, on June. 12, 1990. He received his B.Tech. degree in Electronics and Communication Engineering from Nimra College of Engineering and Technology Vijayawada in 2011, and his M.Tech. degree in Microwave and Communication Engineering from PVP Siddhartha Institute of Technology in 2013. He published a paper on Speech Synthesis. His research interests include Micro strip, RF antennas, Speech Processing and Communication.

[3]**Sk. Masthan Vali** was born in Khammam, on June. 10, 1987. He received his B.Tech. degree in

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Electronics and Communication Engineering from Dr. Samuel George Institute of Engineering and Technology Markapur in 2009, and his M.Tech. degree in Microwave and Communication Engineering from PVP Siddhartha Institute of Technology in 2013. His research interests include Signal Processing , RF antennas and Communication.

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