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Quad Band Microstrip Antenna for Mobile and GNSS application

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Abstract - In various applications, multiband are desirable. This Paper presents the design of a Quad microstrip patch antenna. For this project is use of quad frequency for GSM and IRNSS band. In this system GSM and IRNSS band combine and use at a one platform. The substrate material FR4 is selected for microstrip patch antenna design. An analysis of the return loss, gain of the proposed antenna is carried out using ADS (Advanced Design System) software. The result shows that the return loss of 22.81 dB is achieved at first resonant frequency of 850-900MHz, 19.54 dB at second resonant frequency of 1.84 GHz, 21.08 dB at third resonant frequency of 1.13 GHz, 20.66 dB at forth resonant frequency of 2.5 GHz.

Keywords - *Coaxial feed technique, Advanced Design System (ADS), Rectangular patch, Return loss, FR4 substrate, Gain, Directivity.*

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I. INTRODUCTION

Background of Microstrip Antennas

Antennas are a very important component of communication systems. By definition, a usually metallic device as a rod or wire for radiating or receiving radio waves. In other words the antenna is the transitional structure between free space and a guiding device. In past few decades, reduction in the overall size of communication systems has boosted the research requirement in the field of Microstrip antennas.[1]

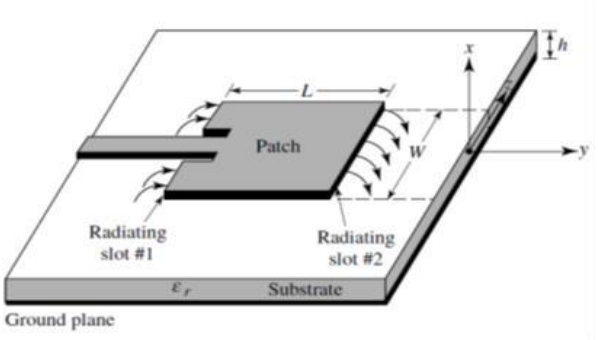

Fig.1 microstrip patch

The microstrip antennas are low profile, comfortable to planar and nonplanar surface, simple and inexpensive to fabricate using morden printed-circuit technology[2]. Microstrip antennas consist of a radiating pattern on one side of a dielectric substrate and a ground plane on other side. Most commonly used shapes are square, rectangular, dipole, and circular because of ease of fabrication and its attractive radiation characteristics.

Motivation for this Study

The motivation for this study evolved from the desire to design a Quad band antenna which can work in GSM and as well as in navigation. In this system GSM and IRNSS band combine and use at a one platform, this technique the antenna very use full for the digital mobile telephony system and navigation and achieve better performance in result.

II. METHODOLOGY ADAPTED

Antenna Shape

In basic form, a patch antenna consists of a radiating patch on one side of a dielectric substrate and other side a ground plane as shown in Figure 1. The patch is made of conducting material like gold or copper and can take any possible shape. The radiating patch is photo etched on the dielectric substrate.

Microstrip patch antennas radiate because of the fringing fields between the ground plane and patch edge. a thick dielectric substrate having a low dielectric constant is provides better efficiency, larger bandwidth[3][4].

Feed Point

The Coaxial feed or probe feed is a very common technique and it is used for feeding Micro strip patch antennas. As seen from Figure 2, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.

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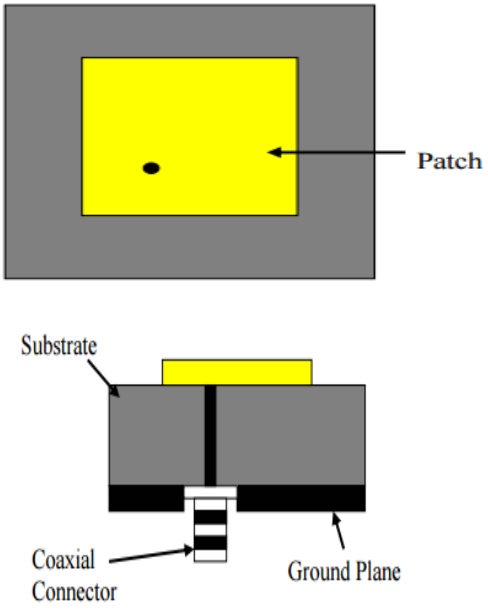

Figure 2 Probe feed Rectangular Microstrip Patch Antenna

The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates (h > 0.02λ0)[6].

III. DESIGN ANALYSIS

Design Specification & calculation

1) Calculation of Width(w):

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \times \sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

2) Calculation of Effective dielectric constant(εreff):

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\,\frac{h}{W}\right]^{-1/2} \quad (2)$$

3) Calculation of effective length(Leff):

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{eff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \quad (3)$$

4) Calculation of the length extension(ΔL):

$$\Delta L = 0.41h * \frac{\varepsilon_{eff} + 0.3}{\varepsilon_{eff} - 0.258} \times \frac{\frac{w}{h} + 0.264}{\frac{w}{h} + 0.8} \quad (4)$$

5) The feed point determination: feed type has been specified and the parameters are calculated. The matching impedance is 50Ω. In order to have a matching of the impedance the connecter has to be placed at some distance from the edge which has a match of 50Ω.

Table 1 Dimension of microstrip

Sr No	Parameter	Design 1	Design 2	Design 3	Design 4
1	Frequency Band	850-900 MHz	1.8 GHz	1.13 GHz	2.5 GHz
2	Dielectric constant of the substrate (εr)	4.6	4.6	4.6	4.6
3	Tangent Loss	0.01	0.01	0.01	0.01
4	Height of dielectric substrate (h)	1.6 mm	1.6 mm	1.6 mm	1.6 mm
5	Calculation of the Width (W)	100.7 mm	49.77 mm	76.14 mm	35.95 mm
6	Calculation of actual length of patch (L)	78.36 mm	38.55 mm	59.20 mm	27.70 mm
7	Gain	1.372 dBi	2.216 dBi	2.030 dBi	1.477 dBi

Procedure of Design patch using ADS software

- File > New > Workspace > Next > Filename > divv > Next > Next > Next > Select Standard Millimeter> Next > Finish.
- File > New > Layout > Ok
- Draw the Patch Antenna and Set the Height and Width of the patch.
- Put feed point.
  - Insert>Pin
- EM>Simulation Setup
  - Frequency plan > Set frequency Range.
  - Substrate
  - Select Substrate New(FR4) > Ok > Select FR4 > material >edit material > add from database > Select required material > Ok > Apply > Ok
  - Select Material from Dropdown list.
  - Set Thickness in millimeters
  - Select Ground plane
- Cover
- Browse > Select from database > copper > ok
- Set Thickness to 0.02 Milimeter
  - Save.
- Select S-parameters > Simulate[7].

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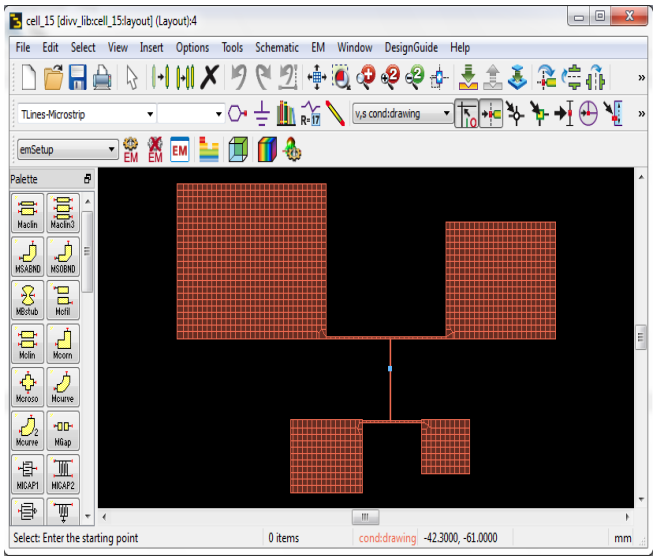
Simulation Result using ADS



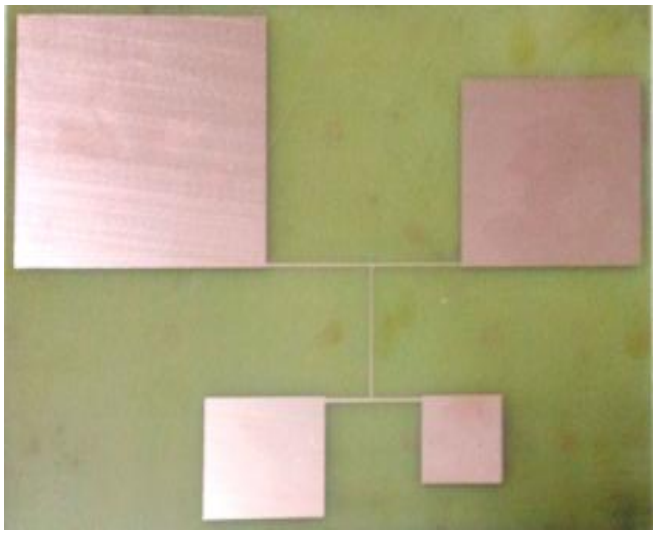


Figure 3 Geometry of purposed antenna

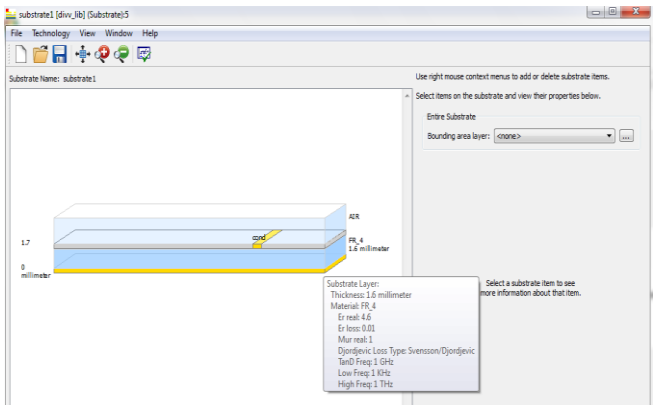


Figure 4 Substrate Selection

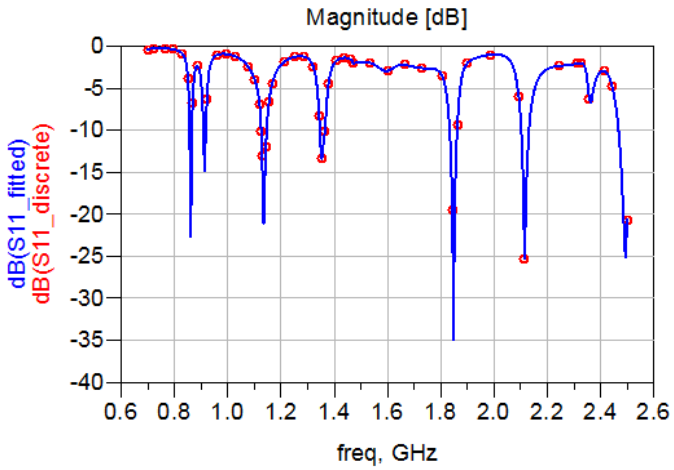


Figure 5 Return loss Vs frequency

IV. CONCLUSIONS

The reference microstrip patch antenna operating in multiband resonant frequency and it can be used to fulfill the demand of navigation and mobile communication. The modern communication systems require Antennas with multi-frequency operation modes. The correlation between geometrical and electrical parameters was calculated. After the optimization the Gain & Return Loss was achieved for the desired frequency Band.

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