Comparison of Stripline and Coaxial Feeding In Rectangular Microstrip Patch Antenna

Sanjay R. Bhongale, Pramod N. Vasambekar

Abstract— The rectangular microstrip patch antenna was designed on FR4 substrate with thickness 0.762mm and dielectric constant $\varepsilon_r = 4.4$ at resonance frequency of 2.45 GHz for ISM band. The excitation of antenna is done by using stripline and coaxial feeding. The transmission line model was used to design the microstrip patch antenna. The Return loss, $S_{11}$ parameter, VSWR, Smith chart and Radiation pattern are simulated by using the ANSOFT Designer SV 2.2. Software. The comparison of these parameters for stripline and coaxial feeding is studied.

Keywords- Antenna feeds, Antenna theory, Microstrip antennas.

I. INTRODUCTION

The microstrip patch antenna plays an important role in modern wireless communication due to its light weight, small size and low cost. Such patch antennas in ISM band can be used in Satellite communication, near field communication (NFC), Cell phones and Bluetooth devices [1]. The microstrip patch antenna is a radiating patch on the dielectric substrate with ground plane on other side. The copper or gold material is used for patch. The patch antennas are fabricated by using microstrip fabrication technique [1]. The excitation of patch antennas can be done by using various feeding technique. The feeding technique plays important role in impedance matching. The input resistance of microstrip antenna depends on position of feed [2]. The types of feeding methods are stripline, coaxial, aperture coupling and proximity coupling. The microstrip patch antennas can be simulated by using softwares like ANSOFT-Designer [3], ADS [4], IE3D [5] and HFSS [6].

In present communication the rectangular microstrip patch antenna by using stripline and coaxial feeding method is designed. The design is analyzed for parameters like return loss, $S_{11}$, VSWR, smith chart, and radiation pattern by using ANSOFT-Designer SV2.2 [7] and the comparison of these results is reported.

II. THEORY OF PATCH ANTENNA

The microstrip patch antenna is in the form of dielectric substrate sandwiched between two conducting metals. It can be designed in different shapes like triangular [3, 8], square [9], rectangular [2], circular [10], E shaped [5]. In present communication rectangular shape is used to design microstrip antenna. The fringing field between patch edge and ground plane makes the antenna to radiate. The dimensions of patch are length L, width W and thickness t on dielectric substrate of height h supported by ground plane as depicted in Fig.1 [1].

Figure 1. Geometry of Rectangular microstrip patch antenna.

The length $L$ of radiating patch in this antenna is usually $0.333\lambda_0 < L < 0.5\lambda_0$, the thickness $t$ of patch is very much less than $\lambda_0$ while height $h$ of dielectric substrate is ranges from $0.003\lambda_0$ to $0.05\lambda_0$, where $\lambda_0$ is the free space wavelength. The dielectric constant $\varepsilon_r$ of the substrate is $2.2 \leq \varepsilon_r \leq 12$ [1].

The transmission line model is used to analyze the microstrip patch antenna [5]. The fringing field between patch edge and ground plane reduces the value of dielectric constant $\varepsilon_r$. The effective dielectric constant is in the range of $1<\varepsilon_{eff}<\varepsilon_r$. The fringing fields are not only in dielectric substrate but are also spread in air as depicted in Fig.2 [1].

Figure 2. Electric field lines

The dimensions like width of patch $W$ [11], Effective dielectric constant $\varepsilon_{eff}$ [12], Extension length $\Delta L$ [13], Length of patch $L$ [12] can be calculated by using the formulae given below.
\[ W = \frac{c}{2f_r \sqrt{\left(\varepsilon_r + 1\right) / 2}} \quad (1) \]

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

\[ \Delta L = 0.412 \left( \frac{W}{h} + 0.264 \right) \left( \varepsilon_{\text{eff}} + 0.3 \right) \left( \varepsilon_{\text{eff}} - 0.258 \right) \left( \frac{W}{h} + 0.8 \right) \quad (3) \]

\[ L = \frac{c}{2f_r \sqrt{\varepsilon_{\text{eff}}}} - (2 \times \Delta L) \quad (4) \]

where \( c = \) Velocity of light in air, \( f_r = \) Resonance frequency, \( h = \) Height of substrate.

Thus by using resonance frequency \( f_r = 2.45 \text{ GHz} \), dielectric material FR4 with \( \varepsilon_r = 4.4 \), height of substrate \( h = 0.762 \text{ mm} \), the width of patch and length of patch of proposed antenna was calculated by using equations 1, 2, 3, 4. These parameters are presented in Table I.

### TABLE I. ANTENNA DIMENSIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric Constant (( \varepsilon_r ))</td>
<td>4.4</td>
</tr>
<tr>
<td>Height of substrate (( h ))</td>
<td>0.762 mm</td>
</tr>
<tr>
<td>Resonance frequency (( f_r ))</td>
<td>2.45 GHz</td>
</tr>
<tr>
<td>Width of Substrate (( W ))</td>
<td>37.26 mm</td>
</tr>
<tr>
<td>Length of Substrate (( L ))</td>
<td>29.084 mm</td>
</tr>
</tbody>
</table>

**A. Feeding Methods**

The excitation of patch antenna can be done with various feeding methods like stripline, coaxial probe, aperture coupling and proximity coupling. For present communication stripline and coaxial feeding methods are used. The stripline is conducting strip with smaller width as compared patch. It is easy to fabricate. The impedance matching is done by choosing specific position at the edge of rectangular patch. In coaxial feeding the inner conductor of SMA is extended through dielectric and connected to conducting patch by soldering while outer conductor is soldered to ground plane.

**III. RESULTS AND DISCUSSION**

The proposed rectangular microstrip antenna is designed; specific location of feed position for stripline and coaxial feeding is optimized and the various parameters of antenna are simulated by using Ansoft Designer SV2.2 software [7].
The simulated results were obtained in the frequency range of 2.0 GHz to 2.8GHz. The variation of return loss with frequency for stripline and coaxial feeding is presented in Fig.4. The corresponding resonance frequency and the return loss are listed in Table II. The resonance frequency of rectangular microstrip patch antenna is observed to be 2.44 GHz for stripline feeding and 2.4GHz for coaxial feeding. it can be noticed that the resonance frequency for stripline feeding is very close to theoretical frequency taken for design as compared to the frequency for coaxial feeding. The return loss is -23.47 dB at 2.44 GHz for stripline feeding and -30.22 dB at 2.4GHz for coaxial feeding. That is the return loss is more negative for coaxial feeding than for stripline feeding. The maximum power about 99.50% transmitted to the antenna in case of stripline feeding whereas in coaxial feeding it is 99.90% [15]. The 3dB and 10 dB % bandwidths are 6.55 and 2.04% for stripline feeding respectively and 7.5 and 2.5 for coaxial feeding respectively.

The variation of S_{11} parameter with frequency is represented in Fig.5. It is 0.06 and 0.03 respectively at resonance frequency for stripline and coaxial feeding.

Fig.6 shows the variation of VSWR with frequency. The VSWR to be 1.06 for stripline feeding and 1.13 coaxial feeding at resonance frequency.

The comparative Smith chart of both feeding methods is represented in Fig. 7.

The half power beam width of designed antenna from radiation pattern in Fig. 8 is 72º and 58º respectively for stripline and coaxial feeding respectively. All these parameters are presented in Table II.

**IV. CONCLUSION**

The stripline and coaxially fed rectangular microstrip patch antenna at 2.45GHz designed on FR4 substrate is studied by using ANSOFT-Designer SV2.2. It is found that,

1) The observed resonance frequency is very close to theoretical resonance frequency for stripline feeding.
2) The return loss is more negative for coaxial feeding than that for stripline feeding.
3) The % 3dB and %10dB bandwidths for stripline feeding are less than that for coaxial feeding.
4) The beam width is higher for stripline than coaxial feeding. The radiation pattern is more directive for coaxial feeding.

**REFERENCES**


