Bandwidth Enhancement of a Microstrip Patch Antenna using Suitable Feed Line Dimension.

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Abstract— Microstrip antenna suffer from narrow bandwidth. The dimension of the microstrip feed line is important in proper impedance matching. A good matching will lead to an enhancement of the bandwidth and return loss. Present study demonstrates the bandwidth enhancement of a microstrip antenna in by using this method. The design antenna operates in the ultra-wide band region. The simulations are conducted using ADS, and results of the simulation are presented in the paper. Furthermore with HFSS, more results are discussed. The simulated results will compare with the mathematical modelling using transmission line. A close proximity justifies the results obtained by this method.

Keywords— Bandwidth, Feedline, Impedance, Patch dimension.

I. Introduction

In last few years, microstrip patch antenna attracted considerable amount of attention of researchers due to demand of its large variety of applications in different fields such as radar, aircraft, missiles, satellite communications, biomedical telemetry, remote sensing, and different other wireless applications. With the wide spread proliferation of wireless communication technology in recent years, the demand for compact, low profile and broadband antennas has increased significantly. To meet the requirement, the microstrip patch antenna has been proposed because of its low profile, light weight and low cost [1]. However, conventional microstrip patch antenna suffers from very narrow bandwidth, typically about 5% bandwidth with respect to the center frequency. This poses a design challenge for the microstrip antenna designer to meet the broadband techniques [2, 3]. Due to this reason, serious efforts started among the scientists, researchers and designers to improve the bandwidth of the patch antenna. Inserting a proper feeding plays a good role in the bandwidth enhancement. Antenna bandwidth is an important parameter of antenna over the range of frequencies fulfilled by the desired antenna characteristics. Antenna bandwidth is described on the basis of Gain, Impedance or VSWR. The Impedance Bandwidth is the range of frequencies over which the input impedance of antenna is perfectly matched to the
characteristic impedance of the feeding transmission line. Most common form of antenna bandwidth to be used in microstrip antenna is the fractional bandwidth on a 10dB point. To maximize the impedance bandwidth [7] proper impedance matching is required. This requires the feed at the driving point of the antenna to be of 50 ohm generally. Some researchers [8] introduce half cut Printed Monopole Technique for matching improvement. Wireless communications in its modern form require an extensive use of various modification of microstrip antenna [9, 10]. Recently many researcher introduces design aspect. This method of feeding is very widely used because it is very simple to design, analyze and very easy to manufacture. This model of the microstrip antenna has simple design, can be simply matched by controlling the inset position and it is easy to fabricate, regarding to the feeding method. Namely, the antenna impedance changes by varying the parameters of the inset (the width and the length). Hence in our discussion we choose the impact of this fed dimension on the return loss and bandwidth.

II. ANTENNA STRUCTURE AND DESIGN
Antenna Structure and Design
The three essential parameters for the design of a rectangular microstrip patch antenna are frequency of operation (f), dielectric constant of the substrate (εr) and height of the substrate (h). All the dimension of the antenna depends on these three above mentioned parameters. The resonant frequency selected for design is 6.0 GHz. The dielectric material selected for the design is FR4-Epoxy which has a dielectric constant of 4.4 and loss tangent of 0.027. A substrate with a high dielectric constant reduces the dimensions of the antenna since the dimensions are inversely proportional to the dielectric constant. The height of the substrate is chosen on the higher side to add the volume and enhancing the bandwidth. Also it is essential that the antenna is not bulky, so the height of the dielectric substrate is selected as 1.6mm. With these values the length and width of the antenna, as calculated from the different sets of equations [10, 11] is come out to be 11.31 mm and 15.21 mm, taking into account the impedance matching with the microstrip line, the length and width is kept at 12 mm and 16 mm. The simulation was performed in ADS and HFSS.

III. RESULT & DISCUSSION
In the first case of observation the height of the substrate and length of the patch is fixed. Both these are the function of the material permittivity and resonant frequency. The length of the patch is kept fixed at 12 mm and the height of the FR4 substrate is taken as 1.6 mm. The width of the patch is varied from 14 cm to 18 cm. Simulation result were observed by varying the width by an interval of 0.25 mm, and the results are plotted in figure 1 below. The results are for both the absolute magnitude of
the return loss and the bandwidth. With 50 Ohm line, the best impedance is observed at 16 mm of the patch width. It is quite obvious that with the changing width, the both the return loss and bandwidth performance of the microstrip antenna changes. Beyond 18 mm, the performance dips below the significant value. The width of the antenna is responsible for the Fringing Effect. With more width the fringing effect is more, but the higher order modes are also generated and this will results in the degradation after certain width.

With these results observed from the various simulation optimizations, the final result is taken with the following dimension of the antenna as shown in table 1 below.

**TABLE 1**

<table>
<thead>
<tr>
<th>Dimension of the Antenna</th>
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<tr>
<td>Length of the Antenna</td>
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<tr>
<td>Width of the Antenna</td>
</tr>
<tr>
<td>Length of Microstrip line</td>
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<tr>
<td>Width of Microstrip line</td>
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<tr>
<td>Height of substrate</td>
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</table>

In next discussion the observation with different dimension of the microstrip line is done. It is observed that the width of the feed line has more dominant effect than the length. The observation is carried with 2mm, 3mm, 4mm and 5 mm width of line and the best result is obtained with 4 mm. The result are shown in figure below.
The return loss (S1 parameter) is shown in figure below. It is clear that, this prototype is giving a very high bandwidth (1.7 GHz) and a maximum return loss of 27 dB.

With HFSS the result is shown below. Here a bandwidth of 1.5 GHz is achieved.

**IV. CONCLUSION**

Imparting a slot of right dimension at the right distance will gives a perfect matching. This results in a good return loss and high bandwidth. The slot intensifies the electric field and enhances the performance of the antenna. By proper selecting the patch dimension and the slot, a broadband antenna can be designed conveniently.

**V. REFERENCES**


