Design and Simulation of a Broad-Band Rectangular Microstrip Antenna by Direct Feed Method

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Abstract— In this paper, the aim is is to increase the bandwidth of microstrip antenna by using direct co-axial feeding technique. The design considerations are given for probe feed rectangular microstrip patch antenna operating at a frequency of 2.4 GHz. The bandwidth of Microstrip antenna is very narrow (2 to 5%). So to enhance the bandwidth, Microstrip patch antenna is fed by co-axial feeding technique along with an array concept.The simulation results show that an antenna with foam substrate has improved bandwidth significantly. By using direct co-axial feed technique the bandwidth has been increased up to 16% . This type of antenna is able to take advantage of Bluetooth (2.3 GHz – 2.55GHz) application.
Detail of increasing the bandwidth is described with IE3D software version 14.0.

Keywords-*Rectangular Microstip Patch Antenna, Bandwidth enhancement, co-axial feed technique.*

1. INTRODUCTION

Microstrip antennas became very popular in the 1970s primarily for space borne applications. Today there are used for government and commercial applications. With the wide spread proliferation of communication technology in recent years, the demand for compact, low profile and broadband antennas has increased significantly. These antennas consist of a metallic patch or a grounded substrate. The metallic patch can take different configurations.

Microstrip antenna performance is affected by the patch geometry, substrate properties and feed techniques. A dielectric substrate with properties such as low loss, low dielectric, and sufficiently thick substrate can provide maximum radiation efficiency and bandwidth. However, the antenna dimensions are large when low dielectric substrates are used. Low loss substrates provide good radiation efficiency, but also make the microstrip antenna a high-Q device, resulting in narrow bandwidth. The use of high dielectric substrates with higher loss gives reduced performance, but greater bandwidth and smaller dimensions.

2. GEOMETRY AND DESIGN

The proposed antenna based on the rectangular patch antenna which must be designed first.. The rectangular microstrip patch antenna fed by co-axial feed technique on the foam substrate with dielectric constant 1.07, loss tangent 0.0009 and 1.5 mm of thickness (h). This antenna is designed at frequency of 2.4GHz, width of the patch is 60mm and length is 55mm for match impedance with 50 ohms of transmission line. The Rectangular Microstrip Patch Antenna is shown in figure 1.

2.1 DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA

The transmission-line model can be used to make a quick preliminary Microstrip antenna design if one knows the substrate parameters, "r and h, and which center frequency, f_0, that is desired. A formula for an efficient patch width is

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

To calculate the length of the patch, it is needed to first calculate ε_{reff} .

The expression for ε *reff* is given by Balanis as:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

The length of the patch (L) is given by

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

The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically as :

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

The effective length of the patch *Leff* is given by

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

3. SIMULATION RESULTS

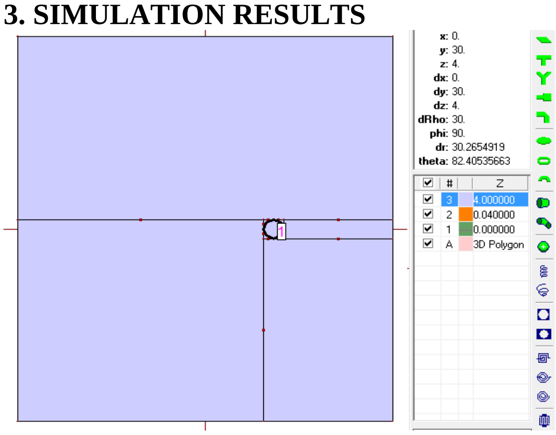


Figure (1): Rectangular Microstrip Patch Antenna

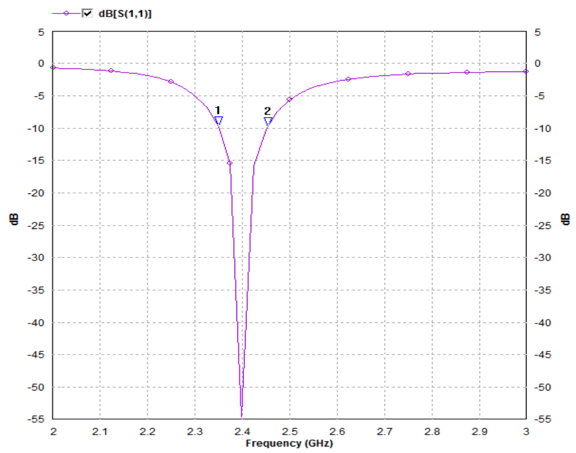


Figure (2) : Return loss and for the Rectangular Microwave

Patch Antenna geometry

% Fractional Bandwidth =(bw/f_c) *100% =4.4166%

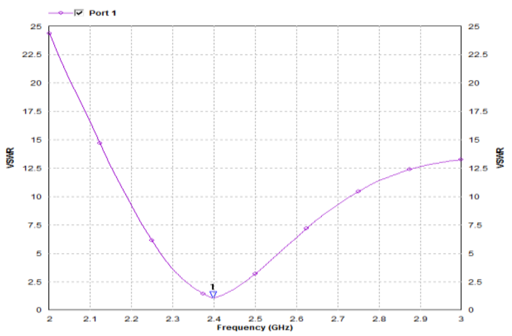


Figure (3): VSWR for the Rectangulat Microstrip patch antenna

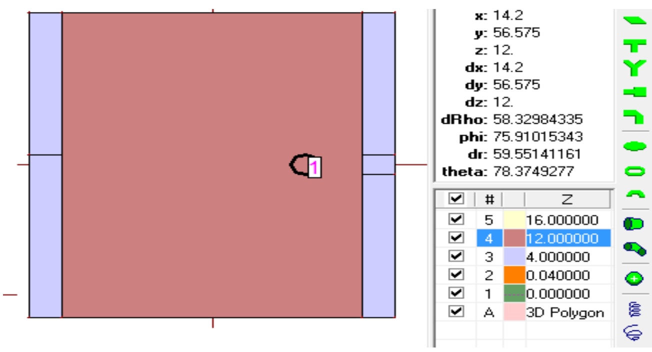
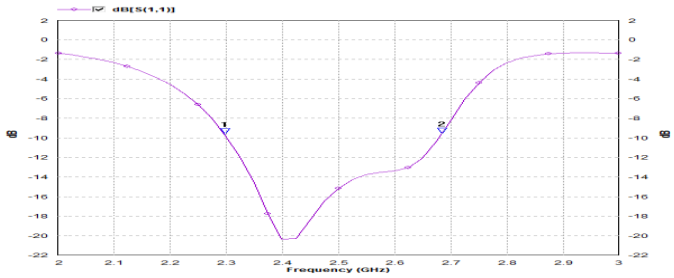
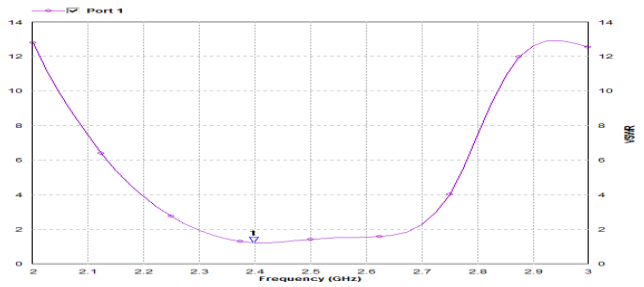


Figure (4) :1-1 Microstrip Antenna Array with Foam-Foam substrate



Figure(5): Return Loss for the 1-1 Rectangular microstrip Antenna with Foam substrate



Figure(6) :VSWR of Rectangular Microstrip Patch Antenna

4. CONCLUSION

The IE3D simulation software V.10 is chosen to simulate the structures shown in the Figures. The S-parameter are obtained from simulation. The simulated result of Rectangular Microstrip Patch Antenna and 1-1 Rectangular Microstrip Patch Antenna with Foam substrate are shown . The first antenna is made from a narrowband rectangular patch antenna designed to resonate at 2.4 GHz, here single feed patch of rectangular shape resulting in BW of 106MHz. The simulation of the second antenna is motivated by the key ideas of bandwidth improvement. Using the parasitic patch (45mm-60mm) the bandwidth increased to 280MHz. And the final results are achieved by use of one parasitic patch and foam as a dielectric substrate for the rectangular patch, providing BW of 386MHz.

5. REFERENCES

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