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PERFORMANCE ANALYSIS OF MICROSTRIP PATCH ANTENNA USING COAXIAL PROBE FEED TECHNIQUE

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Abstract— **Microstrip patch antennas are the most common form of printed antennas. They became very popular due to their low profile geometry, light weight and low cost. A Rectangular Microstrip Patch Antenna with probe feed and substrate used is Arlon AD260 has the relative permittivity of which is 2.6 is designed and simulated using high frequency structure simulator (HFSS). All the Parameters of this microsrip patch Antenna such as bandwidth, S - parameter, Reflection loss and VSWR has been found and plotted. The main objective of this work is to consider the reactive loading effect on the patch and its effect towards the improvement of the antenna characteristics, particularly the radiation characteristics in principle plane (E and H) is examined. As per theoretical approach reactive loading creates either capacitive loading or inductive loading. Due to this effect the antenna performance may be degraded or enhanced in terms of efficiency, isolation, gain, impedance matching etc. The results of this designed antenna are compared with the existing Micro strip antenna.**

Index Terms—**Micro strip Patch Antenna, Coaxial Probe Feed, HFSS, Return Loss.**

I. INTRODUCTION

A microstrip patch antenna is a low profile antenna that has a number of advantages over other antennas which are lightweight, inexpensive, and easy to integrate with accompanying electronics. Microstrip antennas are one of the most widely used types of antennas in the microwave frequency range, and they are often used in the milli metre-wave application. Microstrip patch antennas consist of a metallic patch of conducting material at the top surface with thickness‘t’ and width ‘L’ and a ground plane to its opposite face are separated by a dielectric substrate of thickness *h*, with relative permittivity ε_r as shown in Figure 1. The metallic patch may be of various shapes, among rectangular and circular being the most common. The metallic patch essentially creates a resonant cavity, where the patch is at the top of the cavity, the ground plane is the bottom of the cavity, and the edges of the patch form the sides of the cavity. The edges of the patch act approximately as an open-circuit boundary condition. Hence, the patch acts approximately as a cavity with perfect electric conductor on the top and bottom surfaces, and a perfect “magnetic conductor” on the sides. They can be designed to operate over a large range of frequencies (1- 40 GHz). One advantage of the microstrip patch antenna is that it is has low profile, in the sense that the substrate is fairly thin. The substrate is thin enough, the antenna becomes “conformal, and popular for their low profile geometry, light weight and low cost. The designed microstrip patch antenna can be used in the following applications WLAN, Wireless Sensor Network, Bluetooth, Cordless Telephones and used in most of the ISM band applications, also the designed antenna used in WLAN application. The major disadvantages of the microstrip antenna are that is to be used for narrowband application.

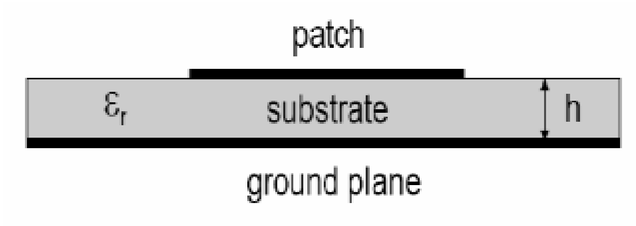

Figure 1: Microstrip Patch Antenna front view.

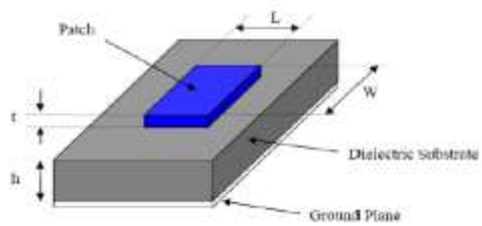

Figure 2: Microstrip Patch Antenna Top View.

II. ANTENNA GEOMETRY FOR PROBE FEED

The detailed design of Microstrip Patch Antenna is shown in Figure 1 and Figure 2. In this design choosing a substrate is as crucial one for its parameters improvements. The selection of dielectric material have many different factors such as dielectric constant, thickness, stiffness as well as loss tangent are considered.

Figure 3 shows the Structure of microstrip antenna. The thickness of the dielectric substrate is h = 2.4 mm and the dielectric constant is 2.6. The antenna is fed by a coaxial probe with characteristic impedance of 50 Ω on the midpoint of one edge of the patch. The resonant frequency of the antenna is 4.24 GHz. The incident field is a linearly polarized plane wave with frequency ranging from 1GHz to 7 GHz.

The resonant frequency of the patch is determined by the patch length. The length of the patch should be slightly less than half the dielectric wavelength. Figure 3, shows the simple rectangular patch antenna. The length, L= 34mm, and width, W= 20mm, the rectangular microstrip patch antenna designed on one side of the Arlon AD260 with ε_r =2.6 and height from the ground plane is 2.4mm with a resonating frequency of 4.24GHz. The above dimension antenna is designed and analyzed using a EM simulator software called High Frequency Structural Simulator(HFSS).

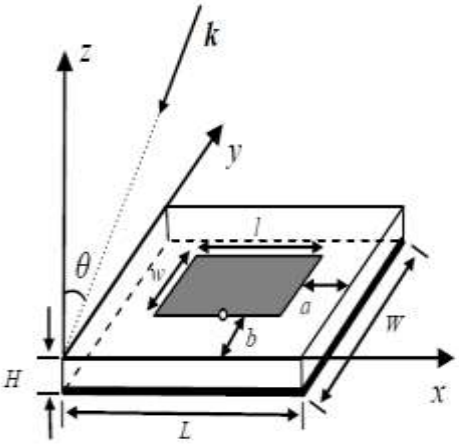

Figure 3: Structure of Microstrip Patch Antenna

The dimension of the designed antenna is given in the Table 1, various parameters are considered while doing the simulation. For this designing purpose we are using substrate material as Arlon AD260 the relative permittivity of which is 2.6.

	Length(L)	Width(W)	Height(h)	ε_r
Patch	34mm	20mm	2.4mm	2.6
Substrate	98mm	60mm	2.4mm	2.6

Table 1: The dimension of Rectangular Patch and Substrate in CM

III. TYPES OF FEED

1. Coaxial Probe Feed-

The coaxial feed or probe feed is a very commonly used to feed the patch located at the top surface of designed antenna. The configuration of a coaxial feed is shown in Figure. 4. 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.

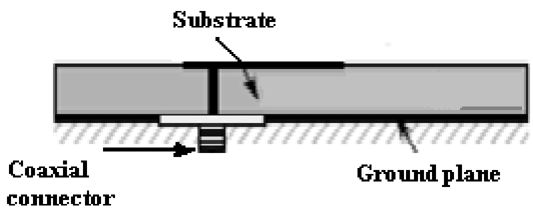

Figure 4: Probe Feed for Microstrip Patch.

2. Aperture Coupled Feed-

In this feeding technique, the radiating patch and the microstrip feed line are separated by the ground plane and coupling between the patch and the feed line is made through a slot or an aperture in the ground plane shown in figure 5. The coupling aperture is usually centered under the patch, which leads to lower the cross-polarization due to symmetry of the configuration. The amount of power coupling from the feed line to the patch is determined by the shape, size and location of the aperture.

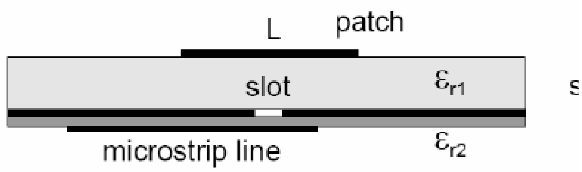

Figure 5: Aperture couple feed for Microstrip Patch

3. Microstrip Line Feed-

In this type of feed technique, a conducting strip is connected directly to the edge of the microstrip patch. This strip is smaller in width as compared to the patch. The major advantage of this arrangement is that the feed can be etched on the same substrate to provide a planar structure.

IV. DESIGN RESULTS

The simulation is done in HFSS (High Frequency Structural Simulator). The simulated result of S11 parameter (return loss) of single element rectangular microstrip patch antenna is presented in figure 6. On the basis of different techniques a Rectangular Probe Feed Patch antenna has been designed and this prototype is improved by applying diffective ground surface(DGS) techniques.

The return loss of Rectangular patch antenna is shown in figure.6, which shows that it is resonating at 4.24GHz frequency.

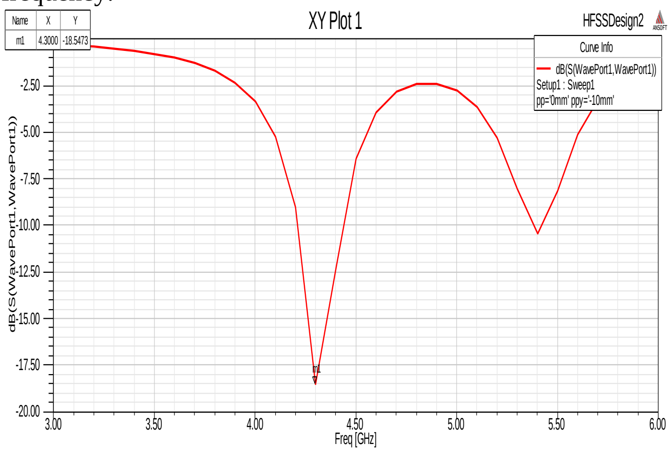

Figure 6: Simulation of S11 Parameter (Return Loss)

Since a Micro strip patch antenna radiates normal to its patch surface, the elevation pattern for φ = 0 and φ = 90 degrees would be important. The radiation pattern for proposed microstrip patch antenna for gain-Total at 0deg and 90deg is presented in figure 7

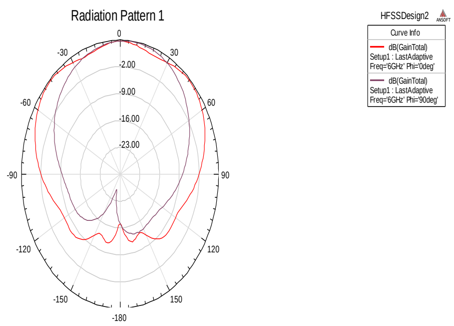

Fig 7: Radiation Pattern of Microstrip Patch

Figure 8 shows the antenna gain pattern and the gain of proposed antenna at 4.24GHz is obtained as 4.80dB.

Fig 8: Gain of Microstrip Patch Antenna

Figure 9 shows the Freq vs dB plot that is VSWR. The VSWR for proposed antenna is obtained as 2.06dB.

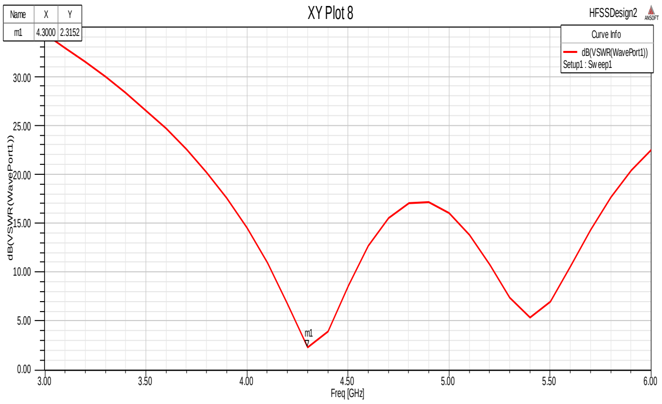

Figure 9: VSWR

V. CONCLUSION

The Microstrip patch antenna is designed for a frequency of 4.24GHz, the patch and ground plane are separated by a dielectric substrate Arlon AD260 with dielectric constant of 2.6, thickness 2.4mm. The main objective of this work is to consider the reactive loading effect on the patch and its effect on the improvement of the antenna characteristics particularly the radiation characteristics in principle plane (E and H) is examined. As per theoretical approach reactive loading creates either capacitive loading or inductive loading. Due to this effect of the antenna performance may be degraded or enhanced in terms of efficiency, isolation, gain, impedance matching etc.

The characteristics of proposed antennas have been investigated through different parametric studies using HFSS simulation software.

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